PHILIPPINE
JOURNAL
OF
SCIENCE

30
MAY-AUG
1926

THE PHILIPPINE JOURNAL OF SCIENCE

VOLUME 30

MAY TO AUGUST, 1926

WITH 30 PLATES AND 7 TEXT FIGURES

MANILA
BUREAU OF PRINTING
1926

218657

General
Water

CONTENTS

No. 1, May, 1926

[Issued May 6, 1926.]

No. 2, June, 1926

[Issued June 17, 1926.]

No. 3, July, 1926

[Issued July 14, 1926.]

No. 4, August, 1926

[Issued August 14, 1926.]

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 30 MAY, 1926 No. 1

CONTRIBUTION TO THE SEROLOGIC GROUPING OF BACILLUS DYSENTERIÆ BASED UPON THE QUALITY OF ANTIGEN AND NORMAL AGGLUTININS

By OTTO SCHÖBL and RITA VILLAAMIL

Of the Division of Biology and Serum Laboratory
Bureau of Science, Manila

As a diagnostic method the agglutination reaction is one of the oldest immune reactions known. The well-known Gruber-Vidal reaction for the diagnosis of typhoid fever has been used for practical purposes, and the principle on which this method is based was in its time applied to serodiagnosis of other bacterial infections.

The identification of isolated strains (intestinal pathogenic bacteria, in particular) by means of agglutination is the most convenient and generally used laboratory method. With the view of specificity, however, research on agglutinins was mainly devoted to the study of immune agglutinins. The normal, or natural, agglutinins have had a theoretical interest only. Bürgi [1] in 1907 admits that very little research has been done on normal agglutinins. His is the most exhaustive study found in the available literature; it includes normal sera from numerous animals and a long series of various microörganisms—among others, *Bacillus dysenteriæ*.

In the course of systematic study by several members of the staff of the Bureau of Science concerning the bacteriology and immunology of bacillary dysentery it became desirable to secure information as to the agglutination of *B. dysenteriæ* by normal

[1] Archiv. für Hygiene 62 (1907) 239–276.

sera of various animals, possible donors of agglutinant sera. Therefore, the investigation here discussed was carried out. In the course of the investigation concerning the presence or absence of agglutinins toward *B. dysenteriæ* (both the Shiga and the Flexner types) in normal sera of laboratory animals, a constant phenomenon was encountered when the serum of normal rabbits was used. This finding was considered of sufficient interest to warrant further investigation of the phenomenon.

STUDY OF AGGLUTININS IN FRESH AND INACTIVATED SERA OF VARIOUS NORMAL ANIMALS TOWARD BACILLUS DYSENTERIÆ (SHIGA AND FLEXNER TYPES)

TECHNIC

Fresh twenty-four-hour-old cultures grown on acid agar (+ 1 phenolphthalein) of one known strain of *B. dysenteriæ* Shiga and one known strain of *B. dysenteriæ* Flexner were used in these agglutination tests.

Sera of the following animals were used: Guinea pig, rabbit, horse, mule, goat, sheep, and monkey. The sera were obtained by bleeding the animals and allowing the blood to coagulate. The clear supernatant serum was centrifuged and decanted carefully. The clear serum of each animal was divided into two equal parts and one part was kept as fresh serum and the other part was heated for thirty minutes at 56° C. The portion kept as fresh serum was again divided into two parts, one for the agglutination test with Shiga strain and one for the agglutination test with Flexner strain. The inactivated (heated) serum of each animal was also divided into two parts, one for agglutination test with Shiga and one for the test with Flexner. Dilutions of the different sera were then made in the following manner:

Seven rows of small test tubes were set up in a rack, eight tubes to each row and one row for each animal. One cubic centimeter of sterile salt solution (0.9 per cent) was introduced into each tube except the first one. To the first tube and to the second tube of each row 1 cubic centimeter of the serum of the respective animal was added. Thus, the second tube of each row contained 1 cubic centimeter of serum and 1 cubic centimeter of salt solution. The contents of the tube were mixed well and 1 cubic centimeter of the mixture was introduced into the third tube, and so on. From the last tube 1 cubic centi-

meter was discarded. In this way, the first tube of each row contained a serum dilution of 1 : 1; the second, a dilution of 1 : 2; the third, 1 : 4; and so on. Emulsions of fresh twenty-four-hour-old acid agar cultures were prepared; one of *B. dysenteriæ* Shiga and one of *B. dysenteriæ* Flexner. This was done by adding 5 cubic centimeters of sterile salt solution (0.9 per cent) to each culture tube. Several culture tubes of acid agar had been planted, some with *B. dysenteriæ* Shiga and some with *B. dysenteriæ* Flexner. With a platinum loop the growth was well emulsified by shaking the tube to secure a homogenous suspension. Then the tubes were allowed to stand for fifteen minutes, or until the larger particles had settled. The homogenous emulsions were then transferred to sterile test tubes.

With sterile pipettes 1 cubic centimeter of the corresponding emulsion was added to each of the tubes containing the corresponding dilution of sera. The results were read after twenty-four hours and they are tabulated in Table 1. In this table the ratios indicate dilutions of the serum; final dilutions are double these ratios. The culture used was a twenty-four-hour-old acid agar culture, emulsified in salt solution (0.9 per cent).

In this and other tables the following symbols are used:

+ + + +	=	Complete.
+ + +	=	Almost complete.
+ +	=	Partial.
+	=	Trace.
±	=	Doubtful.
—	=	Negative.
B	=	Boiling.
RS	=	Rabbit serum.
R	=	Regular.

TABLE 1.—*Showing results of agglutination tests with one strain of Bacillus dysenteriæ Shiga and one strain of B. dysenteriæ Flexner by fresh and inactivated sera of various normal animals.*

	Shiga (fresh serum).							
	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128
Guinea pig	—	—	—	—	—	—	—	—
Rabbit	—	—	—	—	—	—	—	—
Horse	(a)	++++	++++	++++	++++	+++	+	—
Mule	++++	++++	++++	++++	++++	+++	—	—
Goat	+++	+++	++	+	—	—	—	—
Sheep	++++	++++	++++	++++	++	—	—	—
Monkey	—	—	—	—	—	—	—	—

[a] Dissolved.

TABLE 1. *Showing results of agglutination tests with one strain of Bacillus dysenteriæ Shiga and one strain of B. dysenteriæ Flexner by fresh and inactivated sera of various normal animals*—Continued.

	Shiga (inactivated serum).							
	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128
Guinea pig	—	—	—	—	—	—	—	—
Rabbit	—	—	—	—	—	—	—	—
Horse	++++	++++	++++	++++	++++	++	+	—
Mule	++	+++	+++	+++	+++	+	—	—
Goat	+++	+++	++	+	—	—	—	—
Sheep	++++	++++	++++	++++	++	+	—	—
Monkey	—	—	—	—	—	—	—	—
	Flexner (fresh serum).							
Guinea pig	—	—	—	—	—	—	—	—
Rabbit	++	++	++	++	+	—	—	—
Horse	++	++++	++++	++++	++++	++++	++++	+++
Mule	++++	++++	++++	++++	++++	+++	+	—
Goat	++++	++++	++++	+++	++	—	—	—
Sheep	++++	++++	++++	++++	++++	++	+	—
Monkey	—	—	—	—	—	—	—	—
	Flexner (inactivated serum).							
Guinea pig	—	—	—	—	—	—	—	—
Rabbit	++	+	—	—	—	—	—	—
Horse	++++	++++	++++	++++	++++	++++	++	++
Mule	++	+++	+++	+++	+++	+++	++	—
Goat	++++	++++	++++	++++	++	+	—	—
Sheep	++++	++++	++++	++++	++	+	—	—
Monkey	—	—	—	—	—	—	—	—

From the results of these experiments it is evident that—

1. The sera of horse, mule, sheep, and goat contain normal agglutinins for both the Shiga and the Flexner types of *B. dysenteriæ,* the strength of the agglutinant power decreasing in the order mentioned.

2. No normal agglutinins were found to exist in the sera of guinea pig or monkey.

3. The inactivation of the sera of horse, mule, sheep, and goat did not alter appreciably the titer of the sera.

4. The serum of rabbit behaved peculiarly, in as much as it agglutinated the Flexner type of *B. dysenteriæ* but not the Shiga type.

5. On heating, the titer of rabbit serum toward the Flexner type decreased considerably.

The peculiar behavior of the rabbit sera was further investigated. In the first place, it had to be established whether it is a general characteristic of rabbit serum or simply a peculiarity of the particular strains of *B. dysenteriæ* used in these experiments. For that reason all available strains of the Shiga and the Flexner types of *B. dysenteriæ*, partly isolated locally from cases and carriers and partly obtained from abroad, were subjected to quantitative agglutination tests with normal rabbit serum. Furthermore, spontaneous agglutination in physiological salt solution and spontaneous agglutination after boiling for one hour (eventually two hours) were investigated in order to see if and how far the state of the antigen is responsible for the interesting finding. The absorption experiments were performed also with the view to determine the existence of agglutinins. It should be emphasized that sera of thirty-three normal rabbits were used in the course of this investigation and all fundamentally behaved in the same manner.

TECHNIC OF THE QUANTITATIVE AGGLUTINATION TEST WITH NORMAL RABBIT SERUM AND ALL AVAILABLE STRAINS OF BACILLUS DYSENTERIÆ

Transplants were made in acid agar the day previous to the test, of all the Shiga and Flexner strains available. The quantitative agglutination test was done in the following manner: A certain number of normal rabbits were bled. The blood was obtained from the heart of the rabbit by puncture and placed in sterile test tubes (previously rinsed with salt solution to prevent hæmolysis) and allowed to stand in the incubator for one hour. Then the tubes were put in the ice box until the serum separated completely, and the clear sera were pipetted off, pooled, and centrifuged. The clear supernatant serum was decanted and placed in a sterile tube ready for use.

The agglutination test was carried out in the same manner as described before. (See Table 2.)

STUDY OF QUALITATIVE ANTIGEN ANALYSIS OF THE STRAINS OF BACILLUS DYSENTERIÆ SHIGA AND BACILLUS DYSENTERIÆ FLEXNER

All the available Flexner and Shiga fresh twenty-four-hour-old cultures were emulsified in salt solution (0.9 per cent) by adding 5 cubic centimeters of salt solution to one culture slant. The emulsion of each strain was divided into two parts. One part was boiled for one hour at 100° C.; the other part remained as live culture emulsion. The object was to find out the effect of boiling upon the agglutinability of the emulsions. Results were read next day. (See Table 2.)

TABLE 2.—*Showing the results of agglutination tests using normal rabbit serum and all available strains of Bacillus dysenteriæ (Shiga and Flexner types); the results of spontaneous agglutination upon boiling are also shown.*

Culture No.	Titer, fresh rabbit serum.				
	1:1	1:2	1:4	1:8	1:16
1 Shiga	—	—	—	—	—
2 Shiga	—	—	—	—	—
3 Shiga	—	—	—	—	—
4 Shiga	—	—	—	—	—
5 Shiga	—	—	—	—	—
6 Shiga	—	—	—	—	—
7 Shiga	—	—	—	—	—
8 Shiga	—	—	—	—	—
9 Shiga	—	—	—	—	—
10 Shiga	—	—	—	—	—
11 Shiga	—	—	—	—	—
12 Shiga	—	—	—	—	—
13 Shiga	—	—	—	—	—
15 Shiga	—	—	—	—	—
16 Shiga	—	—	—	—	—
17 Shiga	—	—	—	—	—
18 Shiga	—	—	—	—	—
918-2 Shiga	—	—	—	—	—
125,140 Shiga	—	—	—	—	—
Stock Shiga	—	—	—	—	—
T. Mendiola Shiga	—	—	—	—	—
F. Pili Shiga	—	—	—	—	—
Felix Flexner	++++	++++	++++	++	++
185 Carrier Flexner	++++	++++	+++	—	—
1 Flexner	++++	++++	++++	+++	+
2 Flexner	++++	++++	+++	+	—
3 Flexner	++++	++++	++++	++	—
4 Flexner	++++	++++	+++	++	—
5 Flexner	++++	++++	++	—	—
6 Flexner	++++	++++	+++	++	++
7 Flexner	++++	++++	++++	++	—
8 Flexner[b]	—	++++	—	—	—
9 Flexner	++++	++++	++++	++++	++
10 Flexner	++++	++++	++	++	+
11 Flexner	++++	++++	++++	++++	+
12 Flexner	++++	++++	++++	++++	+++
2 Flexner	++++	++++	+++	—	—
3 Flexner	++++	++++	+	—	—
4 Flexner	++++	++++	+++	++	+
9 Flexner	++++	++++	+++	+	—
10 Flexner	++++	++++	+++	+++	±
11 Flexner	++++	++++	++++	+++	—
12 Flexner	++++	++++	+	+	—
14 Flexner	++++	++++	+++	++	+

[b] Contaminated.

TABLE 2.—*Showing the results of agglutination tests using normal rabbit serum and all available strains of Bacillus dysenteriæ (Shiga and Flexner types); the results of spontaneous agglutination upon boiling are also shown*—Continued.

Culture No.	Titer, fresh rabbit serum.				
	1:1	1:2	1:4	1:8	1:16
15 Flexner	++++	++++	+++	+++	—
16 Flexner	++++	++++	+++	+	±
17 Flexner	++++	++++	++	+	—
18 Flexner	++++	+++	+++	+	—
19 Flexner	++++	+++	+++	++	++
20 Flexner	++++	++++	++++	+	—
21 Flexner	++++	++++	++++	+++	—
22 Flexner	++++	++++	++++	±	—
23 Flexner	++++	++++	++++	+	—
24 Flexner	++++	++++	++++	++	—
25 Flexner	++++	++++	++++	+	+
26 Flexner	++++	++++	++++	++++	++++
39 Flexner	++++	++++	++	±	—
40 Flexner	++++	++++	++++	+++	+++
41 Flexner	++++	++++	+++	+	—
1 Flexner	++++	++++	++	+	—
Pickering Flexner	++++	++++	++++	++++	+++
Stock Flexner	++++	++++	++++	++++	++++
Ordoñez Flexner	++++	++++	++++	+++	—
Baniquid Flexner	++++	++++	++++	++++	++++
Pili Flexner	++++	++++	++++	++++	+++
Marabal Flexner	++++	++++	++++	++	—
D. Garcia Flexner	++++	++++	++++	++++	++++
42 Shiga	+++	+++	+++	+	—
43 Shiga	++++	++++	++++	+++	—
44 Shiga	++++	+++	+++	+	—
56 Shiga	++++	++++	++++	++++	+++
59 Shiga	++++	+++	+++	+++	+++
60 Shiga	++++	++++	++++	+	+
66 Shiga	++++	++++	++++	+++	+
67 Shiga	++++	++++	++++	++++	++++
68 Shiga	++++	++++	++++	++	+
69 Shiga	++++	++++	++++	++++	++++
70 Shiga	++++	++++	++++	++++	++++
71 Shiga	++++	++++	++++	++++	++++
D. Flores Shiga	+[d]	+	+	+	+
M. Suzuki Shiga	++++	+++	+++	++	++
A. Espiritu Shiga	+	+	—	—	—
D. Salvatierra Shiga	++++	+++	++	++	—
J. Icaro Shiga	+?	—	—	—	—
S. Palisoc Shiga	++++	++++	++	—	—
M. Reyes Shiga	+	+	±	—	—

[d] A few large flakes with normal rabbit serum.

TABLE 2.—*Showing the results of agglutination tests using normal rabbit serum and all available strains of Bacillus dysenteriæ (Shiga and Flexner types); the results of spontaneous agglutination upon boiling are also shown*—Continued.

Culture No.	Titer, fresh rabbit serum.					
	1:32		1:64		1:128	
1 Shiga	—		—		—	
2 Shiga	—		—		—	
3 Shiga	—		—		—	
4 Shiga	—		—		—	
5 Shiga	—		—		—	
6 Shiga	—		—		—	
7 Shiga	1:32	1:64	1:128	1:256	1:512	1:1024
8 Shiga	—	—	—	—	—	—
9 Shiga	—	—	—	—	—	—
10 Shiga	—	—	—	—	—	—
11 Shiga	—	—	—	—	—	—
12 Shiga	—	—	—	—	—	—
13 Shiga	—	—	—	—	—	—
15 Shiga	—	—	—	—	—	—
16 Shiga	—	—	—	—	—	—
17 Shiga	—	—	—	—	—	—
18 Shiga	—	—	—	—	—	—
918–2 Shiga	—	—	—	—	—	—
125,140 Shiga	—	—	—	—	—	—
Stock Shiga	—	—	—	—	—	—
T. Mendiola Shiga	—	—	—	—	—	—
F. Pili Shiga	—	—	—	—	—	—
Felix Flexner	+	+	±	—	—	—
185 Carrier Flexner	—	—	—	—	—	—
1 Flexner	+	—	—	—	—	—
2 Flexner	—	—	—	—	—	—
3 Flexner	—	—	—	—	—	—
4 Flexner	—	—	—	—	—	—
5 Flexner	—	—	—	—	—	—
6 Flexner	—	—	—	—	—	—
7 Flexner	—	—	—	—	—	—
8 Flexner [b]	—	—	—	—	—	—
9 Flexner	—	—	—	—	—	—
10 Flexner	—	—	—	—	—	—
11 Flexner	—	—	—	—	—	—
12 Flexner	+	—	—	—	—	—
2 Flexner	—	—	—	—	—	—
3 Flexner	—	—	—	—	—	—
4 Flexner	±	—	—	—	—	—
9 Flexner	—	—	—	—	—	—
10 Flexner	—	—	—	—	—	—
11 Flexner	—	—	—	—	—	—
12 Flexner	—	—	—	—	—	—
14 Flexner	—	—	—	—	—	—

[b] Contaminated.

TABLE 2.—*Showing the results of agglutination tests using normal rabbit serum and all available strains of Bacillus dysenteriæ (Shiga and Flexner types); the results of spontaneous agglutination upon boiling are also shown*—Continued.

Culture No.	Titer, fresh rabbit serum.					
	1:32		1:64		1:128	
15 Flexner	—	—	—	—	—	—
16 Flexner	—	—	—	—	—	—
17 Flexner	—	—	—	—	—	—
18 Flexner	—	—	—	—	—	—
19 Flexner	—	—	—	—	—	—
20 Flexner	—	—	—	—	—	—
21 Flexner	—	—	—	—	—	—
22 Flexner	—	—	—	—	—	—
23 Flexner	—	—	—	—	—	—
24 Flexner	—	—	—	—	—	—
25 Flexner	—	—	—	—	—	—
26 Flexner	++	+	—	—	—	—
39 Flexner	—	—	—	—	—	—
40 Flexner	—	—	—	—	—	—
41 Flexner	—	—	—	—	—	—
1 Flexner	—	—	—	—	—	—
Pickering Flexner	++	+	—	—	—	—
Stock Flexner	++++	++++	+++	++	—	—
Ordoñez Flexner	—	—	—	—	—	—
Baniquid Flexner	+++	+	—	—	—	—
Pili Flexner	+++	+	±	—	—	—
Marabal Flexner	—	—	—	—	—	—
D. Garcia Flexner	+++	++	—	—	—	—
42 Shiga	—	—	—	—	—	—
43 Shiga	—	—	—	—	—	—
44 Shiga	—	—	—	—	—	—
56 Shiga	+	—	—	—	—	—
59 Shiga	+	+	—	—	—	—
60 Shiga	—	—	—	—	—	—
66 Shiga	—	—	—	—	—	—
67 Shiga	++++	++++	+	—	—	—
68 Shiga	—	—	—	—	—	—
69 Shiga	++++	++++	+	—	—	—
70 Shiga	++++	++++	++++	—	—	—
71 Shiga	++++	++++	++++	++++	++++	++++
D. Flores Shiga	+	+	+	+	—	—[c]
M. Suzuki Shiga	+	—	—	—	—	—
A. Espiritu Shiga	—	—	—	—	—	—
D. Salvatierra Shiga	—	—	—	—	—	—
J. Icaro Shiga	—	—	—	—	—	—
S. Palisoc Shiga	—	—	—	—	—	—
M. Reyes Shiga	—	—	—	—	—	—

[c] Two hours.

TABLE 2.—*Showing the results of agglutination tests using normal rabbit serum and all available strains of Bacillus dysenteriæ (Shiga and Flexner types); the results of spontaneous agglutination upon boiling are also shown*—Continued.

Culture No.	100 °C. agglutination one hour.	Spontaneous agglutination.	Reaction in mannite.	Source.
1 Shiga	—	—	—	Alabang.
2 Shiga	—	—	—	Do.
3 Shiga	—	—	—	Do.
4 Shiga	—	—	—	Do.
5 Shiga	—	—	—	Do.
6 Shiga	—	—	—	Do.
7 Shiga	—	—	—	Do.
8 Shiga	—	—	—	Do.
9 Shiga	—	—	—	Do.
10 Shiga	—	—	—	Do.
11 Shiga	—	—	—	Do.
12 Shiga	—	—	—	Do.
13 Shiga	—	—	—	Do.
15 Shiga	—	—	—	Do.
16 Shiga	—	—	—	Do.
17 Shiga	—	—	—	Do.
18 Shiga	—	—	—	Do.
918-2 Shiga	—	—	—	P. I., Dr. Vazquez.
125,140 Shiga	—	—	—	P. I., Dr. Lacy.
Stock Shiga	—	—	—	Bureau of Science Laboratory.
T. Mendiola Shiga	—	—	—	Carrier, Dr. Vazquez.
F. Pili Shiga	—	—	—	Do.
Felix Flexner	++++ [a]	—	+	Do.
185 Carrier Flexner	—	—	+	Do.
1 Flexner	—	—	+	Alabang.
2 Flexner	—	—	+	Do.
3 Flexner	—	—	+	Do.
4 Flexner	—	—	+	Do.
5 Flexner	—	—	+	Do.
6 Flexner	—	—	+	Do.
7 Flexner	—	—	+	Do.
8 Flexner [b]	—	—	+	Do.
9 Flexner	—	—	+	Do.
10 Flexner	—	—	+	Do.
11 Flexner	—	—	+	Do.
12 Flexner	—	—	+	Do.
2 Flexner	—	—	+	Morishima.
3 Flexner	—	—	+	Do.
4 Flexner	—	—	+	Do.
9 Flexner	—	—	+	Do.
10 Flexner	—	—	+	Do.
11 Flexner	—	—	+	Do.
12 Flexner	—	—	+	Do.
14 Flexner	—	—	+	Do.
15 Flexner	—	—	+	Do.

[a] Large flakes. [b] Contaminated.

TABLE 2.—*Showing the results of agglutination tests using normal rabbit serum and all available strains of Bacillus dysenteriæ (Shiga and Flexner types); the results of spontaneous agglutination upon boiling are also shown*—Continued.

Culture No.	100 °C. agglutination one hour.	Spontaneous agglutination.	Reaction in mannite.	Source.
16 Flexner	—	—	+	Morishima.
17 Flexner	—	—	+	Do.
18 Flexner	—	—	+	Do.
19 Flexner	—	—	+	Do.
20 Flexner	—	—	+	Do.
21 Flexner	—	—	+	Do.
22 Flexner	—	—	+	Do.
23 Flexner	—	—	+	Do
24 Flexner	—	—	+	Do.
25 Flexner	—	—	+	Do.
26 Flexner	—	—	+	Do.
39 Flexner	—	—	+	Do.
40 Flexner	—	—	+	Do.
41 Flexner	—	—	+	Do.
1 Flexner	++++	—	+	Do.
Pickering Flexner	++++	—	+	Mr. Pickering.
Stock Flexner	—	—	+	Bureau of Science Laboratory.
Ordoñez Flexner	—	—	+	Carrier, Dr. Vazquez.
Baniquid Flexner	++++[a]	—	+	Do.
Pili Flexner	—	—	+	Do.
Marabal Flexner	—	—	+	Do.
D. Garcia Flexner	—	—	+	Do.
42 Shiga	— —[c]	—	—	P. I., Calhoun.
43 Shiga	+?	—	—	P. I., Bellones.
44 Shiga	++	—	—	P. I., Autopsy 10028.
56 Shiga	++++	—	—	P. I., old Laboratory, Dr. Vazquez.
59 Shiga	+?	—	—	P. I., Laboratory, strain Kusama.
60 Shiga	++++	—	—	P. I., Leyte.
66 Shiga	++	—	—	Autopsy 168.
67 Shiga	++++	—	—	A. M. school, U. S.
68 Shiga	+	—	—	Hygiene Lab., U. S.
69 Shiga	++	—	—	Rockefeller Inst., U. S.
70 Shiga	++++	—	—	Hygiene Laboratory, U. S.
71 Shiga	++++	++++	—	Do.
D. Flores Shiga	— —[c]	—	—	P. G. H., Dr. Garcia.
M. Suzuki Shiga	—	—	—	Carrier, Dr. Vazquez.
A. Espiritu Shiga	—	—	—	Do.
D. Salvatierra Shiga	—	—	—	Do.
J. Icaro Shiga	—	—	—	Do.
S. Palisoc Shiga	—	—	—	Do.
M. Reyes Shiga	++++[a]	—	—	Do.

[a] Large flakes. [c] Two hours.

The results of these tests, as compiled in Table 2, brought out the interesting fact that all of the available strains of *B. dysenteriæ* (Flexner type) were readily agglutinable by normal rabbit serum, but only one of them showed agglutination upon boiling for one hour. In the series of *B. dysenteriæ* (Shiga type) more than half of the strains were plainly inagglutinable by rabbit serum. These strains showed no agglutination upon boiling for one hour. As to the agglutinable group of Shiga strains it must be stated that, even though the agglutination was complete at times, in as much as the supernatant fluid in the completely agglutinated tubes was clear, the sediment was found to be rather loose and not so firmly packed as in the case of the Flexner type. The agglutinable group of the Shiga strains falls again into two subdivisions: one, the larger, the members of which agglutinate spontaneously on boiling; and the other, smaller, the members of which do not agglutinate on boiling. The great majority of the strains belonging in the last subdivision are, interestingly enough, strains isolated from carriers. Furthermore, there appears to be a certain quantitative relation between the serum agglutination and the spontaneous agglutination, provoked by boiling for one hour. One spontaneously agglutinable Shiga strain was included in the collection.

STUDY OF THE ADSORPTION OF AGGLUTININS FROM NORMAL RABBIT SERUM BY BACILLUS DYSENTERIÆ, SHIGA AND FLEXNER TYPES

The pooled sera of two rabbits were diluted with an equal amount of sterile salt solution (0.9 per cent) and divided into three equal parts, and each part was placed in a sterile centrifuge tube. The first tube was marked "Shiga;" the second, "Flexner;" and the third, "Control."

Transplants of the cultures to be used were made the day before. These fresh twenty-four-hour-old cultures (four slants of each) were used in the adsorption test. One strain of Flexner type and one strain of Shiga type, both agglutinable by rabbit normal serum, were used. The tube marked "Control" received nothing but the serum and the salt solution. The three tubes were placed in the incubator for one hour. Then they were taken out and placed on top of the incubator, and left there until the next day.

The tube containing serum treated with the Flexner strain was found completely agglutinated the following day. The serum in the tube in which the Shiga strain was emulsified was still somewhat turbid. The control tube remained clear.

The test tubes containing serum and bacterial emulsion were centrifuged until clear. The clear supernatant serum in each tube was carefully decanted and transferred to two other sterilized centrifuge tubes which were marked "Flexner" and "Shiga," respectively. The same procedure of adsorption was repeated a second time, with fresh cultures of the same strains.

A certain amount of agglutination was noticed next day in the tube marked "Flexner," but the supernatant liquid was very turbid. No agglutination was noticed in the tube marked "Shiga." The control serum was clear. The tubes were centrifuged until clear. The clear supernatant liquid was transferred to sterile tubes. Agglutination test was performed with each serum and both Flexner and Shiga strains. (See Table 3.)

TABLE 3.—*Showing results of adsorption test of normal rabbit serum with Bacillus dysenteriæ, Shiga and Flexner types.*

I. SERUM ADSORBED BY SHIGA STRAIN 70.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128
Shiga 70	+++	+++	++	+	—	—	—	—
Flexner	++++	++++	+++	+	—	—	—	—

II. SERUM ADSORBED BY FLEXNER STRAIN 1.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128
Shiga 70	++	++	+	—	—	—	—	—
Flexner	+	—	—	—	—	—	—	—

III. UNTREATED SERUM.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128
Shiga 70	+++	+++	+	—	—	—	—	—
Flexner	++++	++++	+++	++	—	—	—	—

Other Shiga strains were tested with the adsorbed serum that remained from the previous test. Fresh twenty-four-hour-old acid agar cultures were used. One strain of Flexner was included also. The agglutination tests were made in exactly the same way as described in the previous test. The results were read next day. (See Table 4.)

TABLE 4.—*Showing results of adsorption test of normal rabbit serum with Bacillus dysenteriæ, Shiga and Flexner types.*

SERUM ADSORBED BY SHIGA STRAIN 70.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128
Shiga 68	++	++	—	—	—	—	—	—
Shiga 69	++	++	++	—	—	—	—	—
Shiga 71	++	++	++	++	++	++	++	++
Flexner 1	++++	+++	+	—	—	—	—	—

SERUM ADSORBED BY FLEXNER STRAIN 1.

Shiga 68	+	—	—	—	—	—	—	—
Shiga 69	+	—	—	—	—	—	—	—
Shiga 71	+	+	+	+	+	+	+	+
Flexner 1	—	—	—	—	—	—	—	—

UNTREATED SERUM.

Shiga 68	+++	+++	++	+	—	—	—	—
Shiga 69	++	+	—	—	—	—	—	—
Shiga 71	++++	++++	++++	++++	++++	++++	++++	+++
Flexner 1	++++	++++	++	—	—	—	—	—

Additional adsorption tests were performed, using other strains.

The pooled sera of four rabbits were divided into seven equal parts, and each part was placed in a sterile centrifuge tube. The tubes were marked according to the cultures that were to be used in the tests and were numbered from I to VI. The following cultures, planted the day before the test, were used in this experiment:

Shiga D. Flores.—This is a Shiga strain which was found agglutinable in normal rabbit serum, but nonagglutinable on heating for one or two hours.

Flexner 26.—This is a regular Flexner strain, highly agglutinable in normal rabbit serum, but nonagglutinable on heating.

Shiga 42.—This is a Shiga strain agglutinable in normal rabbit serum, but nonagglutinable on heating for one or two hours.

Shiga 2.—This strain behaves regularly and is nonagglutinable in normal rabbit serum and on heating.

Shiga 71.—This Shiga strain agglutinates in fresh normal rabbit serum. It also agglutinates spontaneously, as well as on heating.

The serum in each tube was diluted with an equal amount of sterile salt solution (0.9 per cent). Then the serum in tube I was absorbed with the Shiga culture D. Flores; tube II, with Flexner 26; tube III, with Shiga 42; tube IV, with Shiga 2; tube V, with Shiga 71. Tube VI received nothing but the serum and the salt solution and was marked "control serum." All the tubes were then placed in the incubator for one hour, after which time they were taken out and placed on top of the incubator and left there until next day.

On the next day, the serum in which Shiga 71 was emulsified was found completely agglutinated. The other sera were turbid, showing agglutination as indicated above. The untreated serum was clear.

All the tubes were centrifuged. The clear sera were transferred to other sterile centrifuged tubes and marked accordingly. They were treated in exactly the same way as was done the day before; that is, more bacteria were added to each tube. The next day there was complete agglutination in the tube marked Shiga 71; no agglutination in the other tubes was noticed.

The tubes were again centrifuged and the clear sera transferred to sterile tubes and kept in the ice box.

The procedure followed in these agglutination tests was the same as that described for the previous tests. Each of the adsorbed sera, including the control serum, was tested with each of the strains in question. Results were read next day. (See Table 5.)

Further adsorption tests were performed, using other strains. (See Tables 6 and 7.)

The adsorption experiments showed that one strain of Flexner adsorbed its own agglutinins, but none of the Shiga strains adsorbed the agglutinins of the Flexner strains tested. One Flexner strain adsorbed its own agglutinins, and all of those of the Shiga strains at times, while another strain of Flexner adsorbed its own agglutinins, but not those of the other Flexner strain nor those of the Shiga strains. From all these findings it is evident that the agglutination of Flexner strains behaves fairly regularly and constantly with normal rabbit serum, whereas the agglutination of the Shiga strains is not constant, the adsorption of Shiga agglutinins from normal rabbit serum being irregular even with the same strains. These findings would seem to indicate that such irregularities may be due to the quality of the Shiga antigen, particularly when we consider that the great majority of the smaller group of Shiga strains

TABLE 5.—*Showing results of adsorption test of normal rabbit serum with Bacillus dysenteriæ, Shiga and Flexner types.*

I. SERUM ADSORBED BY SHIGA STRAIN D. FLORES, SLIGHTLY IRREGULAR.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	Control	Remarks.
Shiga D. Flores	+	+	±	—	—	—	—	—	—	—	—	—	
Flexner 26	++++	++++	++++	+++	+	±	—	—	—	—	—	—	
Shiga 42	—	—	—	—	—	—	—	—	—	—	—	—	
Shiga 2	+	+	±	—	—	—	—	—	—	—	—	—	
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	Very small flakes throughout.

II. SERUM ADSORBED BY FLEXNER 26, REGULAR

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	Control	Remarks.
Shiga D. Flores	—	—	—	—	—	—	—	—	—	—	—	—	
Flexner 26	—	—	—	—	—	—	—	—	—	—	—	—	
Shiga 42	—	—	—	—	—	—	—	—	—	—	—	—	
Shiga 2	—	—	—	—	—	—	—	—	—	—	—	—	
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	Sedimentation and very small flakes throughout.

III. SERUM ADSORBED BY SHIGA STRAIN 42, IRREGULAR.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	Control	Remarks.
Shiga D. Flores	—	—	—	—	—	—	—	—	—	—	—	—	
Flexner 26	+++	+++	+++	+++	+++	+	+	—	—	—	—	—	
Shiga 42	—	—	—	—	—	—	—	—	—	—	—	—	
Shiga 2	—	—	—	—	—	—	—	—	—	—	—	—	
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	Small flakes.

IV. SERUM ADSORBED BY SHIGA 2, REGULAR.

Shiga D. Flores	—	—	—	—	—	—	—	—	—	—	—	—	
Flexner 26	++++	++++	+++	+	—	—	—	—	—	—	—	—	
Shiga 42	—	—	—	—	—	—	—	—	—	—	—	—	
Shiga 2	—	—	—	—	—	—	—	—	—	—	—	—	
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	Small flakes.

V. SERUM ADSORBED BY SHIGA 71, SPONTANEOUSLY AGGLUTINABLE.

Shiga D. Flores	—	—	—	—	—	—	—	—	—	—	—	—	
Flexner 26	++++	++++	+++	++	+	—	—	—	—	—	—	—	
Shiga 42	—	—	—	—	—	—	—	—	—	—	—	—	
Shiga 2	—	—	—	—	—	—	—	—	—	—	—	—	
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	Small flakes.

VI. CONTROL SERUM, UNTREATED.

Shiga D. Flores	+++	++	+	+	+	±	—	—	—	—	—	—	
Flexner 26	++++	++++	++++	++++	+++	++	+	—	—	—	—	—	
Shiga 42	++	+	—	—	—	—	—	—	—	—	—	—	
Shiga 2	—	—	—	—	—	—	—	—	—	—	—	—	
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	Small flakes.

TABLE 6.—*Showing results of adsorption of normal rabbit serum with Bacillus dysenteriæ, Shiga and Flexner types.*

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	Control.
SERUM ADSORBED BY FLEXNER 26, REGULAR FLEXNER.												
Shiga Flores	++	++	—	—	—	—	—	—	—	—	—	—
Flexner 26	—	—	—	—	—	—	—	—	—	—	—	—
Shiga 42	+	±	±	—	—	—	—	—	—	—	—	—
Shiga 2	—	—	—	—	—	—	—	—	—	—	—	—
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++
SERUM ADSORBED BY SHIGA 71, SPONTANEOUSLY AGGLUTINABLE.												
Shiga Flores	++++	+++	+	—	—	—	—	—	—	—	—	—
Flexner 26	++++	++++	++++	+++	+	++	+	—	—	—	—	—
Shiga 42	+	+	—	—	—	—	—	—	—	—	—	—
Shiga 2	—	—	—	—	—	—	—	—	—	—	—	—
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++
CONTROL SERUM.												
Shiga Flores	++++	+++	++	+	—	—	—	—	—	—	—	—
Flexner 26	++	+	±	—	—	—	—	—	—	—	—	—
Shiga 42	++	—	—	—	—	—	—	—	—	—	—	—
Shiga 2	—	—	—	—	—	—	—	—	—	—	—	—
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++

SERUM ADSORBED BY SHIGA FLORES.

Shiga Flores	+	++	+	—	—	—	—	—	—	—	—	—
Flexner 26	++++	++++	+++	++	—	—	—	—	—	—	—	—
Shiga 42	—	—	—	—	—	—	—	—	—	—	—	—
Shiga 2	—	—	—	—	—	—	—	—	—	—	—	—
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++

SERUM ADSORBED BY SHIGA 42.

Shiga Flores	++	—	—	—	—	—	—	—	—	—	—	—
Flexner 26	++++	++++	++++	++++	+++	—	—	—	—	—	—	—
Shiga 42	+	+	+	—	—	—	—	—	—	—	—	—
Shiga 2	—	—	—	—	—	—	—	—	—	—	—	—
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++

TABLE 7.—*Showing results of adsorption test of normal rabbit serum with Bacillus dysenteriæ, Shiga and Flexner types.*

SERUM ADSORBED BY SHIGA 2.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	Control.
Shiga Flores	—	—	—	—	—	—	—	—	—	—	—	—
Flexner 26	++++	+++	++	+	±	—	—	—	—	—	—	—
Shiga 42	—	—	—	—	—	—	—	—	—	—	—	—
Shiga 2	—	—	—	—	—	—	—	—	—	—	—	—
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++

CONTROL SERUM.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	Control.
Shiga Flores	+	+	±	—	—	—	—	—	—	—	—	—
Flexner 26	++++	++++	+++	++	±	—	—	—	—	—	—	—
Shiga 42	±	+	+	—	—	—	—	—	—	—	—	—
Shiga 2	—	—	—	—	—	—	—	—	—	—	—	—
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++

I. SERUM ADSORBED BY SHIGA 4, REGULAR SHIGA.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	Control.
Shiga Flores	—	—	—	—	—	—	—	—	—	—	—	—
Flexner 26	++++	++++	+++	+	±	—	—	—	—	—	—	—
Shiga 42	—	—	—	—	—	—	—	—	—	—	—	—
Shiga 2	—	—	—	—	—	—	—	—	—	—	—	—
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++
Flexner 1	+++	++	—	—	—	—	—	—	—	—	—	—
Flexner 12	+++	++	—	—	—	—	—	—	—	—	—	—
Shiga 4	+	—	—	—	—	—	—	—	—	—	—	—

II. SERUM ADSORBED BY FLEXNER 12, REGULAR FLEXNER.

Shiga Flores	++	+	±	—	—	—	—	—	—	—	—	—
Flexner 26	+++	+++	++	+	+	—	—	—	—	—	—	—
Shiga 42	++	++	+	—	—	—	—	—	—	—	—	—
Shiga 2	—	—	—	—	—	—	—	—	—	—	—	—
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++
Flexner 1	++	++	—	—	—	—	—	—	—	—	—	—
Flexner 12	—	+++	—	—	—	—	—	—	—	—	—	—

III. CONTROL SERUM.

Shiga Flores	+++	++	++	+	—	—	—	—	—	—	—	—
Flexner 26	++++	+++	+++	+++	—	—	—	—	—	—	—	—
Shiga 42	++	+	±	—	—	—	—	—	—	—	—	—
Shiga 2	+	—	—	—	—	—	—	—	—	—	—	—
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++
Flexner 1	++++	+++	+++	+	—	—	—	—	—	—	—	—
Flexner 12	++++	++++	+	—	—	—	—	—	—	—	—	—
Shiga 4	+	—	—	—	—	—	—	—	—	—	—	—

was found to be heat agglutinable, that the titer of the rabbit serum toward the Shiga strain is low, and especially when we consider the character of the agglutinate. As already mentioned, the sediment in the case of the Flexner strains is firmly packed, and when stirred shows mostly large flakes, whereas the sediment of the Shiga strains is loose, and the agglutinate consists of small microscopic flakes very similar to those found in the spontaneously agglutinable strains or in the strains agglutinated by boiling. This difference in the character of the agglutinate, observed early in these experiments, led us to undertake the qualitative antigen analysis, which disclosed the fact that the majority of the Shiga strains agglutinable by normal rabbit serum were heat agglutinable—a phenomenon which we are inclined to consider as a tendency on the part of the particular strain to spontaneous agglutinability brought about by boiling.

STUDY OF AGGLUTINATION AND ADSORPTION OF AGGLUTININS, USING POLYVALENT ANTIDYSENTERIC HORSE SERUM AND ALL AVAILABLE STRAINS OF BACILLUS DYSENTERIÆ

In order to substantiate this explanation the only thing for us to do was to extend our adsorption tests to immune serum. There is a statement [2] in the literature concerning agglutination to the effect that spontaneously agglutinable strains do not adsorb agglutinins of their kind. By means of this phenomenon it was hoped to demonstrate such relation as might exist between the spontaneously agglutinable and the heat agglutinable strains of the Shiga type of *B. dysenteriæ*. The phenomenon itself having been found with *B. typhosus*, it became necessary to learn whether it occurred also in the case of *B. dysenteriæ*. The immune serum used in these experiments was antidysenteric immune horse serum. It was prepared by subcutaneous injections of emulsions of eighteen Shiga cultures and twenty Flexner cultures. The Shiga cultures were the strains marked S 1 to S 18 in our tables.

The agglutination test (Table 8) with this serum shows that in a dilution 1:6 all of the strains included in this experiment were completely agglutinated, that is to say, twenty-one strains of regular Shiga; by regular Shiga we mean strains agglutinable by polyvalent antidysenteric serum, nonagglutinable by normal rabbit serum, and nonagglutinable on boiling

[2] Teague, Oscar, and Helen I. McWilliams, Journ. of Immunology 2 (1916–1917) 383–393.

for one hour. Other Shiga strains, designated as irregular, were also agglutinated completely; by irregular Shiga strains we mean strains agglutinable by polyvalent immune serum, more or less agglutinable by normal rabbit serum, and agglutinable or nonagglutinable on boiling one hour. It appears, therefore, that the polyvalent antidysenteric serum agglutinated not only the regular strains that were used in its preparation, but also the irregular ones that had not been injected into the horses.

TABLE 8.—*Showing the results of adsorption tests of polyvalent antidysenteric serum by regular, irregular, and spontaneously agglutinable strains of Bacillus dysenteriæ Shiga.*

[Dilution of serum, 1: 6.]

Strain No.	Serum adsorbed by S 2.	Serum adsorbed by S 70.	Serum adsorbed by S 71.	Untreated serum.	Control.	Remarks.
S 1	—	++++	++++	++++	—	R
S 2	—	++++	++++	++++	—	R
S 3	—	++++	++++	++++	—	R
S 4	—	++++	++++	++++	—	R
S 5	—	++++	++++	++++	—	R
S 6	—	++++	++++	++++	—	R
S 7	—	++++	++++	++++	—	R
S 8	—	++++	++++	++++	—	R
S 9	—	++++	++++	++++	—	R
S 10	—	++++	++++	++++	—	R
S 11	—	++++	++++	++++	—	R
S 12	—	++++	++++	++++	—	R
S 13	—	++++	++++	++++	—	R
S 14	—	++++	++++	++++	—	R
S 15	—	++++	++++	++++	—	R
S 16	—	++++	++++	++++	—	R
S 17	—	++++	++++	++++	—	R
S 18	—	++++	++++	++++	—	R
918-2	—	++++	++++	++++	—	R
125140	—	++++	++++	++++	—	R
Stock Shiga	—	++++	++++	++++	—	R
S 42	—	++++	++++	++++	—	RS+ B—
S 43	++++	++++	++++	++++	—	RS+ B+
S 44	—	++++	++++	++++	—	RS+ B+
S 56	++++	++++	++++	++++	—	RS+ B+
S 59	++++	++++	++++	++++	—	RS+ B+
S 60	++++	++++	++++	++++	—	RS+ B+
S 66	++++	++++	++++	++++	—	RS+ B+
S 67	++++	++++	++++	++++	+	RS+ B+
S 69	—	++++	++++	++++	—	RS+ B+
S 70	++++	++++	++++	++++	—	RS+ B+
S 71	++++	++++	++++	++++	++++	Spontaneously agglutinable.
D. Flores	—	++++	++++	++++	—	RS+ B—
Suzuki	++++	++++	++++	++++	—	RS+ B—
Salvatierra	+++	++++	++++	++++	—	RS+ B—
Palisoc	+	++++	++++	++++	—	RS+ B—

The adsorption test showed that one regular Shiga strain adsorbed agglutinins for all regular Shiga strains and also for four of the irregular strains. Whether this adsorption was complete or not in the case of the irregular strains is not evident from this experiment, because only one dilution of the serum was used. However, when the polyvalent antidysenteric serum was adsorbed by an irregular strain (that is, a strain which was agglutinable both by rabbit normal serum and on boiling) no adsorption of agglutinins took place, either for the regular strains or for the irregular ones. The strain agglutinable by normal rabbit serum and on boiling behaved in this respect in the same way as did the spontaneously agglutinable strain.

A quantitative agglutination test was made using the polyvalent antidysenteric horse serum and three serologically regular Shiga strains, four irregular Shiga strains (that is to say, agglutinable by normal rabbit serum and on boiling), one slightly irregular strain (that is, agglutinable by normal rabbit serum but not on boiling), and one spontaneously agglutinable Shiga strain. It is interesting to note that the regular Shiga strains that were used for the production of the serum were agglutinated to a lower degree than were the irregular ones that were not used for the immunization of the horses. The slightly irregular Shiga strain gave about the same titer as did the regular ones.

When the serum was adsorbed by any of the three regular Shiga strains, the agglutinins for the regular ones disappeared completely, while those for the irregular ones only partially disappeared. The irregular strains adsorbed partially for the irregular ones and not at all for the regular ones. The slightly irregular strain, on the other hand, adsorbed partially for the regular strains as well as for the irregular ones.

In the next experiment (Table 10) one portion of the polyvalent immune horse serum, referred to above, was adsorbed by the regular Shiga strain, and another portion by the regular Flexner strain. The agglutination test with the untreated polyvalent serum showed that the regular Shiga and the Flexner strains were agglutinated to about the same dilution. When the serum was adsorbed by the regular Shiga, it decreased the titer for Flexner very slightly, whereas it lost the agglutinins for regular Shiga completely and also partially for the irregular strain and for the slightly irregular strain.

TABLE 9.—*Showing the results of adsorption tests of polyvalent antidysenteric horse serum by various strains of Bacillus dysenteriæ Shiga.*

CONTROL SERUM, UNTREATED.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	1:2048	1:4096	Control.	Remarks.
S 59	++++	++++	++++	++++	++++	++++	++++	++++	++++	++	—	—	—	—	RS+ B+?
S 60	++++	++++	++++	++++	++++	++++	++++	++++	++++	++	—	—	—	—	RS+ B+
S 66	++++	++++	++++	++++	++++	++	—	—	—	—	—	—	—	—	RS+ B+
S 1	++++	++++	++++	++++	++	+	—	—	—	—	—	—	—	—	RS— B—
S 2	++++	++++	++++	++++	++	+	—	—	—	—	—	—	—	—	RS— B—
S 3	++++	++++	++++	++++	+++	++	—	—	—	—	—	—	—	—	RS— B—
S Flores	++++	++++	++++	++++	+	—	—	—	—	—	—	—	—	—	RS— B—
S 70	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	+++	++	++	—	RS+ B+
S 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	Spontaneously agglutinable.

SERUM ADSORBED BY S 1, REGULAR SHIGA; DOES NOT AGGLUTINATE WITH RABBIT SERUM OR ON BOILING.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	1:2048	1:4096	Control.	Remarks.
S 60	++++	++++	++++	++++	++++	+++	+	—	—	—	—	—	—	—	RS+ B+
S 66	++++	++++	+++	++	+	—	—	—	—	—	—	—	—	—	RS+ B+
S 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	RS— B—
S 2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	RS— B—
S 3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	RS— B—

SERUM ADSORBED BY S 2, REGULAR SHIGA; DOES NOT AGGLUTINATE WITH RABBIT SERUM OR ON BOILING.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	1:2048	1:4096	Control.	Remarks.
S 60	++++	++++	++++	++++	++++	++++	++	—	—	—	—	—	—	—	RS+ B+
S 66	++++	++++	++++	+++	—	—	—	—	—	—	—	—	—	—	RS+ B+
S 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	RS— B—
S 2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	RS— B—
S 3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	RS— B—
S 70	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++	—	—	—	RS+ B+
S 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	Spontaneously agglutinable.

TABLE 9.—*Showing the results of adsorption tests of polyvalent antidysenteric horse serum by various strains of Bacillus dysenteriæ Shiga*—Continued.

SERUM ADSORBED BY S 3, REGULAR SHIGA; DOES NOT AGGLUTINATE WITH RABBIT SERUM OR ON BOILING.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	1:2048	1:4096	Control.	Remarks.
S 60	++++	++++	++++	++++	++++	++++	+++	+	—	—	—	—	—	—	RS+ B+
S 66	++++	++++	++++	++++	+	—	—	—	—	—	—	—	—	—	RS+ B+
S 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	RS— B—
S 2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	RS— B—
S 3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	RS— B—

SERUM ADSORBED BY S 59, IRREGULAR SHIGA; AGGLUTINATES WITH RABBIT SERUM AND ON BOILING.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	1:2048	1:4096	Control.	Remarks.
S 59	++++	++++	++	—	—	—	—	—	—	—	—	—	—	—	RS+ B+?
S 60	++++	++++	++++	++++	++++	++	—	—	—	—	—	—	—	—	RS+ B+
S 66	++++	++++	++++	++++	+++	++	+	—	—	—	—	—	—	—	RS+ B+
S 1	++++	++++	++++	++++	++++	+	—	—	—	—	—	—	—	—	RS— B—
S 2	++++	++++	++++	++++	++++	+++	+	—	—	—	—	—	—	—	RS— B—
S 3	++++	++++	++++	++++	++++	+++	—	—	—	—	—	—	—	—	RS— B—

SERUM ADSORBED BY S 60, IRREGULAR SHIGA; AGGLUTINATES WITH RABBIT SERUM AND ON BOILING.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	1:2048	1:4096	Control.	Remarks.
S 59	++++	++++	++++	++++	++++	++++	++++	++++	+++	++	—	—	—	—	RS+ B+?
S 60	++++	++++	++++	++++	++++	++++	++++	+++	+	—	—	—	—	—	RS+ B+
S 66	++++	++++	++++	++++	++++	+++	++	—	—	—	—	—	—	—	RS+ B+
S 1	++++	++++	++++	++++	++++	+++	++	—	—	—	—	—	—	—	RS— B—
S 2	++++	++++	++++	++++	++++	++	—	—	—	—	—	—	—	—	RS— B—
S 3	++++	++++	++++	++++	++++	+++	—	—	—	—	—	—	—	—	RS— B—

SERUM ADSORBED BY S 66, IRREGULAR SHIGA; AGGLUTINATES WITH RABBIT SERUM AND ON BOILING.

S 59	++++	++++	++++	++++	++++	++++	++	+	—	—	—	—	—	—	RS+ B+?
S 60	++++	++++	++++	++++	++++	++++	+++	++	+	—	—	—	—	—	RS+ B+
S 66	++++	++++	++++	++++	++++	++++	+++	—	—	—	—	—	—	—	RS+ B+
S 1	++++	++++	++++	++++	++++	+++	—	—	—	—	—	—	—	—	RS— B—
S 2	++++	++++	++++	++++	++++	+++	+	—	—	—	—	—	—	—	RS— B—
S 3	++++	++++	++++	++++	++++	+++	+	—	—	—	—	—	—	—	RS— B—

SERUM ADSORBED BY SHIGA 70, IRREGULAR SHIGA; AGGLUTINATES WITH RABBIT SERUM AND ON BOILING.

Shiga 2	++++	++++	++++	++++	+++	+	—	—	—	—	—	—	—	—	RS— B—
Shiga 70	++++	++++	++++	++++	++++	++++	++++	+++	+++	+++	++	+	—	—	RS+ B+
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	Spontaneously agglutinable.

SERUM ADSORBED BY SHIGA 71, IRREGULAR SHIGA, SPONTANEOUSLY AGGLUTINABLE.

Shiga 2	++++	++++	++++	+++	++	+	±	—	—	—	—	—	—	—	RS— B—
Shiga 70	++++	++++	++++	++++	++++	++++	++++	++++	+++	+++	+++	++	—	—	RS+ B+
Shiga 71	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	Spontaneously agglutinable.

SERUM ADSORBED BY S. FLORES, SLIGHTLY IRREGULAR SHIGA; AGGLUTINATES WITH RABBIT SERUM, BUT NOT ON BOILING.

S 60	++++	++++	++++	++++	++++	+++	+	—	—	—	—	—	—	—	RS+ B+
S 66	++++	++++	+++	+	—	—	—	—	—	—	—	—	—	—	RS+ B+
S 1	++++	+++	—	—	—	—	—	—	—	—	—	—	—	—	RS— B—
S 2	++++	+++	+	—	—	—	—	—	—	—	—	—	—	—	RS— B—
Flores	+++	++	++	—	—	—	—	—	—	—	—	—	—	—	RS+ B—

TABLE 10.—*Showing the results of adsorption tests of polyvalent antidysenteric serum by regular strains of Bacillus dysenteriæ Shiga and B. dysenteriæ Flexner.*

CONTROL SERUM, UNTREATED.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:123	1:256	1:512	1:1024	1:2048	Control.	Remarks.
S 1	++++	++++	++++	++++	++++	++	—	—	—	—	—	—	—	RS— B—
Flexner 12	++++	++++	++++	++++	++++	+++	++	—	—	—	—	—	—	RS+ B—
S Flores	++++	++++	++++	++++	++++	++++	++	+	—	—	—	—	—	RS+ B—
S 70	++++	++++	++++	++++	++++	++++	++	—	—	—	—	—	—	RS+ B+

SERUM ADSORBED BY FLEXNER 12, REGULAR FLEXNER; AGGLUTINATES WITH RABBIT SERUM, BUT NOT ON BOILING.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:123	1:256	1:512	1:1024	1:2048	Control.	Remarks.
S 1	++++	++++	++++	++++	++++	++++	++	—	—	—	—	—	—	RS— B—
Flexner 12	+	+	+	+	+	—	—	—	—	—	—	—	—	Small flakes.
S Flores	++++	++++	++++	++++	++++	+	—	—	—	—	—	—	—	RS+ B—
S 70	++++	++++	++++	++++	++++	+++	—	—	—	—	—	—	—	RS+ B— RS+ B+

SERUM ADSORBED BY S 1, REGULAR SHIGA; DOES NOT AGGLUTINATE WITH RABBIT SERUM OR ON BOILING.

	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:123	1:256	1:512	1:1024	1:2048	Control.	Remarks.
S 1	+	—	—	—	—	—	—	—	—	—	—	—	—	RS— B—
Flexner 12	++++	++++	++++	++++	++++	+	—	—	—	—	—	—	—	RS+ B—
S Flores	++++	+++	++	+	±	—	—	—	—	—	—	—	—	RS+ B—
S 70	+++	+++	+++	+	—	—	—	—	—	—	—	—	—	RS+ B+

When adsorbed with the regular Flexner strain, the polyvalent serum agglutinated the regular Shiga as well as the irregular and the slightly irregular to about the same degree as the untreated serum. The Flexner strain adsorbed completely the specific agglutinins for Flexner but left the small flake agglutinins preserved.

This finding is of interest. The fact that the majority of the irregular Shiga strains were agglutinated to a higher degree than were the regular ones and, further, that they did not adsorb the agglutinins of the regular strains or their own completely, pointed to the possibility that the irregular Shiga strains had highly developed Flexner receptors and that the residual agglutinins were the Flexner agglutinins because the serum was polyvalent. The adsorption test with the Flexner strain of the polyvalent serum shows, however, that this is not the case and that the inability of the irregular strains to adsorb agglutinins of their group and their own is due to the change in antigen or its receptor system. The slightly irregular strain behaves again more like the regular ones than the strains which proved agglutinable on boiling and with normal rabbit serum.

STUDY OF THE QUALITY OF ANTIGEN OF BACILLUS DYSENTERIÆ BY ACID AGGLUTINATION (MICHAELIS)[3]

Further to substantiate our view we undertook a series of tests tending to show the influence of ion concentration on the agglutinability of all of the various strains of *Bacillus dysenteriæ* in our collection.

The method employed was the acid agglutination, as introduced by Michaelis. Six solutions were made according to the scheme given below. A distilled water control and physiological salt solution controls were included in the test. It was found that the maximum of agglutination with the regular strains took place in solutions V and VI. The line of demarcation with the regular Shiga strains is rather sharp, and agglutination occurs in the tubes of highest ion concentration. The regular Flexner strain behaved in the same way, with a few exceptions, where small flakes were found in solutions containing lower concentration than that in solution V. With the irregular strains the range of agglutination was shifted to the left, and distinct agglutination was found in tubes containing a

[3] Kolle, W., and H. Metsch, Die experimentelle Bakteriologie, etc., 6th ed. 1 (1922) 184.

lower ion concentration than that in tube V. The spontaneously agglutinable strain and six other irregular Shiga strains gave complete agglutination in all of the tubes and, strange to say, Flexner's strains isolated from carriers behaved similarly with regard to acid agglutination.

These findings would seem to be confirmatory evidence of our view expressed above.

TECHNIC

The acid agglutination was carried out in the following manner: The bacterial suspensions were made in distilled water and each tube received 0.5 cubic centimeter of the suspension and 0.5 cubic centimeter of the corresponding solution. The reading was taken on the next day.

The scheme of solutions used for acid agglutination tests was as follows:

	cc.
Solution I:	
Normal sodium hydroxide	5
Normal hydrochloric acid	7.5
Water	87.5
Solution II:	
Normal sodium hydroxide	5
Normal hydrochloric acid	10
Water	85
Solution III:	
Normal sodium hydroxide	5
Normal hydrochloric acid	15
Water	80
Solution IV:	
Normal sodium hydroxide	5
Normal hydrochloric acid	25
Water	70
Solution V:	
Normal sodium hydroxide	5
Normal hydrochloric acid	45
Water	50
Solution VI:	
Normal sodium hydroxide	5
Normal hydrochloric acid	85
Water	10
Solution VII:	
Control	
Distilled water	
Solution VIII:	
Normal salt solution, 0.9 per cent	
Control	

A series of eighteen regular Shiga strains was subjected to the acid agglutination test. It can be seen from Table 11, in

which the results are tabulated, that the regular strains behaved fairly uniformly. Although the agglutination was not complete, the maximum with all strains was noticed in solutions V and VI. Furthermore, the range of agglutination is sharply defined.

TABLE 11.—*Showing the results of acid agglutination (regular Shiga strains).*

	Solution I.	Solution II.	Solution III.	Solution IV.	Solution V.	Solution VI.	Control.	Remarks.
S 1	—	—	+	++	++	+	—	RS— B—
S 2	—	—	—	+	++	+	—	RS— B—
S 3	—	—	—	++	++	++	—	RS— B—
S 4	—	—	—	+	++	+	—	RS— B—
S 5	—	—	—	+	++	++	—	RS— B—
S 6	—	—	—	+	++	++	—	RS— B—
S 7	—	—	—	++	++	++	—	RS— B—
S 8	—	—	—	+	++	++	—	RS— B—
S 9	—	—	—	+	+	++	—	RS— B—
S 10	—	—	—	+	++	++	—	RS— B—
S 12	—	—	—	—	+	++	—	RS— B—
S 13	—	—	—	—	+	++	—	RS— B—
S 14	—	—	—	—	±	++	—	RS— B—
S 15	—	—	—	—	+	++	—	RS— B—
S 16	—	—	—	—	+	+	—	RS— B—
S 17	—	—	—	—	++	++	—	RS— B—
S 18	—	—	—	—	++	++	—	RS— B—

The irregular strains (Table 12), however, behaved differently, in as much as the majority of them agglutinated far more strongly than did the regular ones, and they usually had a much wider range of positive agglutination; or, in other words, the optimum of positive agglutination shifted toward the end of the lower ion concentration. Several behaved similarly to the spontaneously agglutinable strain, in as much as complete or almost complete agglutination took place in all of the six solutions. They are not, however, as sensitive as is the spontaneously agglutinable strain which, though it remains in even suspension in distilled water, is brought to flocculation by the mere presence of 0.9 per cent of sodium chloride.

For the sake of completeness, rather than to bring more evidence of the correctness of our view, expressed above, the acid agglutination test was also applied to all the available strains of mannite fermenters (Table 13). They were all regular Flexner strains (that is, agglutinable by normal rabbit serum and nonagglutinable on boiling for one hour) with one exception (I), which was agglutinable on boiling; and, although this

TABLE 12.—*Showing the results of acid agglutination (thirteen irregular Shiga strains).*

	Solution I.	Solution II.	Solution III.	Solution IV.	Solution V.	Solution VI.	H_2O control.	Control emulsion.	Remarks.
S 42	+++	+++	+++	+++	+++	+++	—	—	RS+ B—
S 43	—	+	+	++++	+	—	—	—	RS+ B+
S 44	—	±	±	+++	++	±	—	—	RS+ B+
S 56	—	—	+	++++	++	++	—	—	RS+ B+
S 59	—	—	±	+	±	±	—	—	RS+ B+?
S 60	—	—	+	++	++	±	—	—	RS+ B+
S 66	±	±	±	++	+	±	—	—	RS+ B+
S 67	++++	++++	++++	++++	++++	++++	—	—	RS+ B+
S 68	—	±	±	±	±	—	—	—	RS+ B+
S 69	—	±	+	+	+	±	—	—	RS+ B+
S 70	++++	++++	++++	++++	++++	++++	—	—	RS+ B+
S Flores	—	—	++	++	++	++	—	—	RS+ B—
S 71	++++	++++	++++	++++	++++	++++	—	++++	RS+ B+

strain showed only a slight degree of agglutination, the range of agglutinability extended over all of the six solutions. The general tendency with mannite fermenters is to have the optimum ion concentration corresponding to solutions VI, V, and IV. Some of them extended farther to the lower ion concentration but showed no irregularity in normal rabbit serum or on boiling.

TABLE 13.—*Showing the results of acid agglutination (regular Flexner strains).*

	Solution I.	Solution II.	Solution III.	olution IV.	Solution V.	Solution VI.	Control VII.	Remarks.
Fl. 1	+	+	+	+	+	+	—	RS+ B+
Fl. 2	—	—	+	+++	+++	++	—	RS+ B—
Fl. 3	+	+	+	+	+	+	—	RS+ B—
Fl. 4	—	—	+	+++	+++	++	—	RS+ B—
Fl. 9	—	—	+	++	++	++	—	RS+ B—
Fl. 10	—	—	+	+	+++	+	—	RS+ B—
Fl. 11	—	—	+	++	++	++	—	RS+ B—
Fl. 12	—	—	+	+++	+++	++	—	RS+ B—
Fl. 14	—	—	—	++	+++	++	—	RS+ B—
Fl. 15	—	—	—	++	+++	++	—	RS+ B—
Fl. 16	—	+	+++	+++	+++	+++	—	RS+ B—
Fl. 17	—	—	+	++	+++	++	—	RS+ B—
Fl. 18	—	—	++	+++	+++	++	—	RS+ B—
Fl. 19	+	++	+++	+++	+++	+++	—	RS+ B—
Fl. 20	—	—	+	+++	+++	+++	—	RS+ B—
Fl. 21	—	—	—	+	++	++	—	RS+ B—
Fl. 22	—	—	—	++	++	++	—	RS+ B—
Fl. 23	—	+	+	++	+++	++	—	RS+ B—
Fl. 24	—	—	—	+	++	++	—	RS+ B—
Fl. 25	—	—	—	++	++	++	—	RS+ B—
Fl. 26	—	—	—	—	±	—	—	RS+ B—
Fl. 39	—	—	+	+++	+++	+++	—	RS+ B—
Fl. 40	—	—	—	+++	+++	++	—	RS+ B—
Fl. 41	—	—	—	+	++	++	—	RS+ B—

SUMMARY

Two types of *Bacillus dysenteriæ,* Shiga and Flexner were subjected to agglutination tests by normal sera of the following animals: Guinea pig, rabbit, horse, mule, goat, sheep, and monkey. It was found that the sera of horse, mule, sheep, and goat agglutinate both the Flexner and the Shiga types of *B. dysenteriæ.* The rabbit serum behaved peculiarly, in as much as it agglutinated promptly all the Flexner strains available, forming large flakes and firmly packed sediment.

The majority of the Shiga strains available (that is, strains isolated locally from patients and carriers as well as cultures

obtained from abroad) were nonagglutinable by normal rabbit serum, while a smaller number of Shiga strains were agglutinated by normal rabbit serum. The largest number of the latter were agglutinable by boiling.

In the adsorption experiments the Flexner type adsorbed the agglutinins for the corresponding strains regularly, from normal rabbit serum, whereas the Shiga strains showed irregular results; that is, serum adsorbed by the Shiga strains did not adsorb the Flexner agglutinins, whereas sometimes it agglutinated the Shiga strains and sometimes it did not.

In view of the character of the agglutinate (that is, mostly small flakes and loose sediment) and in view of the irregularity of adsorption and, particularly, of the fact that the majority of these Shiga strains are agglutinable on boiling, the agglutination of Shiga strains in general by normal rabbit serum is believed to be due to the quality of the antigen of certain strains rather than to the presence of real agglutinins such as one finds for Flexner strains in normal rabbit serum.

Our smaller group of mannite nonfermenters agrees remarkably with the small group in our collection which was found to represent a serologic small group when monovalent serum was used and to produce indol, thus resembling the Flexner strains in this respect (Lacy).[4] The small group was found to be agglutinable by the polyvalent immune horse serum to a higher degree than were the regular strains, although the regular strains were used exclusively for the preparation of the serum.

The majority of the small group (that is, the strains agglutinable by normal rabbit serum) were found to be spontaneously agglutinable on boiling for one hour in a suspension of salt solution. There were, however, some members of this group that were agglutinable by normal rabbit serum, but were not agglutinable on boiling.

When the adsorption test of the polyvalent immune horse serum was performed the regular strains showed reciprocity in complete adsorption of agglutinins within their group and adsorbed partially the agglutinins for the irregular strains. The members of our small group adsorbed partially their own agglutinins but did not adsorb the agglutinins of the regular

[4] Philip. Journ. Sci. **28** (1925) 313–328.

strains. Two strains were encountered that were agglutinable by normal rabbit serum, but not on boiling, and which adsorbed partially agglutinins for both the regular and the irregular Shiga strains, thus forming an intermediate stage between the regular and the irregular strains. It is interesting to note that these strains, according to the classification by monovalent serum, belong to the larger group (Lacy).[5] Another strain, spontaneously agglutinable in salt solution suspension, adsorbed neither for the regular nor for the irregular strain, thus forming the extreme end of the serological stages of mannite nonfermenters. In agreement with this serologic grouping by the use of qualitative antigen analysis and normal agglutinins, the regular Shiga strains showed a narrow, sharply defined zone of agglutination when subjected to the acid agglutination test; that is, the agglutination was restricted and most pronounced in the solutions of highest ion concentration. The irregular Shiga strains, that is, agglutinable by normal rabbit serum and agglutinable or nonagglutinable by boiling, showed as a rule a more pronounced agglutination and a wide range of positive agglutination not infrequently extending over all of the six solutions used.

The mannite fermenters on the average showed a similar optimum of acid agglutination as did the nonfermenters, but the range was somewhat wider than that in Shiga strains.

DISCUSSION

If we consider the findings presented in this paper and use them as a basis for interpretation of the serological grouping of mannite nonfermenters, as offered by Lacy,[6] we can hardly escape the impression that the gradual degeneration of the antigen of the bacteria of one group is responsible for the differences in agglutinability of the various strains and the consequent serologic grouping.

As rightly pointed out by Lacy the preliminary test of identification of *Bacillus dysenteriæ* by agglutination with monovalent agglutinant serum is not advisable, in as much (as Lacy has shown) as the small group would have escaped the attention of the bacteriologist diagnostician. From our results, however, it can be seen that the polyvalent antidysenteric horse serum,

[5] Loc. cit. [6] Loc. cit.

as prepared by us for therapeutic purposes and used as a preliminary identification test of suspicious colonies on plates, agglutinates the members of the small group to at least as high a degree as its homologous strains and frequently to a much higher degree.

In our experiments the regular Shiga strains were found resistant to agglutination by serum of their own to a higher degree than were the irregular ones. The sensitiveness to agglutination of the latter by the serum of the former is expressed by their being more highly agglutinable by the serum of the regular strains than are the regular strains themselves. This is further emphasized by the fact that they are agglutinable by normal rabbit serum and more so by the fact that the majority of the strains are agglutinable on boiling for one hour.

Thus we have a series of stages of susceptibility to agglutination from the regular Shiga strains that are comparatively slightly agglutinable by homologous immune horse serum, nonagglutinable by normal rabbit serum, and nonagglutinable on boiling; have a sharply defined optimum of acid agglutination restricted to the solutions of highest ion concentration; adsorb completely agglutinins of their own as well as of all members of their group and adsorb partially those of the irregular strains of mannite nonfermenters, to the extreme other end, represented by the spontaneously agglutinable strain so susceptible to agglutination that the mere presence of the small amount of sodium chloride in physiologic salt solution will bring about agglutination. All degrees of gradual degeneration are represented in our collection, between the regular strains and the spontaneously agglutinable strains. There are strains which agglutinate by rabbit serum only and not on boiling and have a wide range of agglutination in the acid agglutination test, and those which agglutinate on boiling as well as by rabbit serum and show high susceptibility to acid agglutination. Some of these adsorb their own agglutinins and those of their group, while others behave with respect to adsorption as well as to acid agglutination in exactly the same manner as does the spontaneously agglutinable strain.

Hand in hand with the increase of susceptibility to agglutination there goes a decrease in their adsorbing capacity. We find that an immune horse serum prepared with the regular strains agglutinates all the Shiga strains in our collection; but

the adsorption experiment shows the fine serologic distinction between the two groups. In connection with these observations we must not omit to mention the findings of Morishima [7] who, working in the Bureau of Science on the constancy of types of *Bacillus dysenteriæ,* found that the serum prepared by the original mother culture agglutinated itself as well as the variant. The serum prepared by the variant agglutinated the variant itself and the mother culture; but, while the mother culture adsorbed agglutinins of its own as well as those for the variant, the variant adsorbed the agglutinins for itself only, but not those for the mother culture.

It is evident that there is a partial loss in the receptor system of certain serologic groups of *Bacillus dysenteriæ,* while the changes as noticed by Morishima in mannite fermenters were not only serologic, but also cultural, in as much as it was possible to change the "Y" type into a Flexner type and vice versa; it was impossible to induce mannite nonfermenters to change their fermenting properties. In our case the only explanation is that the irregular strains of mannite nonfermenters have gradually variated, but the mannite nonfermenters, being very stable as far as fermentation of carbohydrate is concerned, gradually and partially lost their adsorbing receptor system but retained their fermentative properties intact. The grouping of our collection into serologic groups by Lacy [8] finds its explanation in our experiments and in those of Morishima.[9]

In accordance with the receptor theory of Ehrlich, we have to assume three systems of receptor; one, which causes the emulsion to agglutinate when brought in contact with immune serum; another, which adsorbs the agglutinins from the immune serum; and a third, which stimulates the production of agglutinins when injected into the animal's body (agglutinogen).

The agglutinogenic property of our strains has not been tested by us, in view of the fact that this part of the work has been done by Lacy with a fairly representative number of the members of our collection. We can, therefore, use the results of his investigation to advantage, as far as the explanation of our results is concerned. From the accompanying table (Table 14) the remarkable agreement between the grouping by Lacy

[7] Philip. Journ. Sci. 29 (1926) 447–463.
[8] Philip. Journ. Sci. 25 (1925) 313–328.
[9] Philip. Journ. Sci. 29 (1926) 447–463.

TABLE 14.—*Showing the results of our classification of Bacillus dysenteriæ Shiga strains and that made by G. R. Lacy, using the same strains.*

Grouping based on quality of antigen and normal agglutinins (Schöbl and Villaamil).			Grouping based on agglutinogenic property and monovalent agglutinins (Lacy).		
Regular group.	Slightly irregular group.	Irregular group.	I, large group.	II, small group.	III, subgroup.
Strain.	*Strain.*	*Strain.*	*Strain.*	*Strain.*	*Strain.*
1	42	43	1	43	Espiritu.
2	Flores.	44	2	44	Salvatierra.
3		56	3	56	Reyes.
4		59	4	59	Mendiola.
5		60	5	60	F. Pili.
6		66	6	66	
7		67	7	Suzuki.	
8		68	8		
9		69	9		
10		70	10		
11		71	11		
12		Suzuki.	12		
13		Espiritu.	18		
14		Salvatierra.	42		
15		Reyes.	Flores.		
16					
17					
18					
Mendiola.					
F. Pili.					

of the mannite nonfermenting group of *Bacillus dysenteriæ* (based on the agglutinogenic property of the strains) and our grouping (based on the quality of antigen and normal agglutinins) is at once evident. Our slightly irregular strains (Flores 42) belong in the large group of Lacy, while the members of Lacy's subgroup, which agglutinated neither with the large group nor with the small group of sera, are distributed over our regular and irregular groups.

STUDIES ON THE SEROLOGY OF LEPROSY, I

THE WASSERMANN REACTION IN LEPROSY [1]

By ELOY V. PINEDA

Of the Pathological Section, Culion Leper Colony, Philippine Health Service

and

ELISA ROXAS-PINEDA

Of the Medical Section, Culion Leper Colony, Philippine Health Service

INTRODUCTION

Leprosy has long been considered as preëminently the non-treponematous disease that yields a positive Wassermann reaction. The majority of workers who have investigated the matter have affirmed this. A peculiar feature is that there are wide differences in the reports as to the frequency of positive reactions, the percentages varying from as low as 20 to practically 100. Further, in many instances fixation is incomplete. Therefore, it is evident that the situation is very different from that in syphilis and yaws. Comparatively recently the contrary view has been advanced; namely, that leprosy, uncomplicated, does not give rise to positive reactions. However, most of those interested in the subject are under the earlier impression.

It was felt that the matter should be investigated further with the view to determining which view should be adopted. This is of importance, quite aside from any possible value of the reaction in the diagnosis of doubtful cases of leprosy and from the theoretic interest in view of the otherwise practical specificity of the reaction; for the reaction can be used as an indication and guide for the necessary treatment of complicating syphilis or yaws in lepers only in case there is assurance that it is not caused by leprosy itself. Furthermore, this information was desired by the staff of the pathological section of the Culion Leper Colony, in connection with projected studies on other phases of the serology of leprosy. The findings in five hundred

[1] Published on recommendation of the Philippine Leprosy Research Board and with the approval of the Director of Health.

cases are here given, together with a consideration of the effect of antitreponematous therapy in certain of the positive cases.

LITERATURE

It would be fruitless repetition to review extensively the literature on the subject of the Wassermann reaction; this can be found in a recent paper by Kolmer and Denney.[2] Of the papers reporting positive results we will cite only those that have been published recently, as they are fairly representative.

Goodpasture,[3] working in the Philippines, reports positive results in eight (62 per cent) of thirteen untreated cases and in eleven (85 per cent) of thirteen undergoing chaulmoogra treatment that were still clinically and bacteriologically positive. In sixteen cases that had become clinically and bacteriologically negative as a result of treatment, he found the reaction uniformly negative. He believes, therefore, that a positive Wassermann reaction in leprosy is due to infection with the bacillus of leprosy, and that the disappearance of the reaction is a specific phenomenon associated with clinical improvement and diminution in the number of the acid-fast bacilli.

Lloyd, Muir, and Mitra[4] report from India that they found the reaction completely positive in 41.7 per cent of two hundred twenty-eight cases examined; if the partially positive reactions are included, this figure is brought to 53.5 per cent. Of twenty-seven purely nodular cases 70.4 per cent were positive in some degree; of one hundred sixteen mixed cases, 62.9 per cent; and of eighty-five anæsthetic cases, 35.2 per cent. In fifty-eight children examined, 81 per cent were completely or partially positive, including all of four nodular cases, all but one of twenty mixed cases, and 70 per cent of thirty-four anæsthetic cases.

Later, however, in their study on the effect of antisyphilitic treatment on the reaction in leprosy[5] these authors conclude that many of the cases were suffering from syphilis also, but they apparently still believe some of the positive reactions to be due to leprosy. Recently, Muir stated[6] that, with further treatment of these cases, the apparent influence of syphilis in this connection is becoming greater.

[2] Arch Derm. & Syph. 8 (1923) 63.
[3] Philip. Journ. Sci. 22 (1923) 428.
[4] Ind. Journ. Med. Res. 11 (1923) 1.
[5] Ind. Journ. Med. Res. 12 (1924) 213–220.
[6] Personal communication.

Schöbl and Basaca,[7] in a study of the distilled water (globulin) precipitation reaction in leprosy, performed the Wassermann reaction in parallel with that test and obtained about 35 per cent positives. However, most of the reactions were very weak, for eight of the eleven were plus-minus, and two were 1-plus.

Of the many reports on this subject very few record failure to obtain positive results. So far as we are aware, Bloombergh[8] was the first to question the occurrence of the reaction in leprosy. He examined twenty-one cases and in only three was it positive. Of these, one gave a history of syphilis; the other two were unfortunately lost sight of. He, therefore, considered it doubtful that a positive reaction is to be obtained as a result of infection with the bacillus of leprosy.

Ten years ago Mathis and Baujean[9] definitely stated that the Wassermann reaction is negative in cases of pure leprosy. Their work was apparently ignored by subsequent workers, and Mathis[10] presented another paper at the recent leprosy conference in Strassbourg, confirming the previous report. The technic of Calmette and Massol was used in this work.

Kolmer and Denney[11] report uniformly negative results in nonsyphilitic cases with the former's new standardized technic, though with an old technic about 7 per cent of the same sera were positive.

TECHNIC

Two methods were employed by us. All of the sera were tested by the new standardized method of Kolmer[12] and most of them by this method alone. This was primarily chosen, both because of the results with it in leprosy reported by Kolmer and Denney, and because it is admitted by several workers[13] to be superior as regards the diagnosis of syphilis. It

[7] Philip. Journ. Sci. 25 (1924) 1.

[8] Philip. Journ. Sci. § B 6 (1911) 335.

[9] Bull. Soc. Path. Exot. 8 (1915) 252.

[10] La reaction de Wassermann dans la lèpre. Troisieme Conference International Scientifique de la Lèpre, Strassbourg, 28–31 Juillet, 1923, Paris. J. B. Balliere et Fils, 19 Rue Hautejouille (1924) 229–231.

[11] Arch. Derm. & Syph. 8 (1923) 63.

[12] Am. Journ. of Syphilis, VI, 1 (1922).

[13] Shivers, C. H. de T., Arch. Derm. & Syph. 6 (1922) 344; Kilduffe, R. A., Arch. Derm. & Syph. 6 (1922) 709; Palmer, L. J., and W. E. Gibbs, Arch. Derm. & Syph. 6 (1922) 738; Irvine, H. G., and D. Stern, Arch. Derm. & Syph. 8 (1923) 818; Schamberg, J. F., and S. S. Greenbaum, Journ. Am. Med. Assoc. 80 (1923) 836–838.

would seem that, if in uncomplicated cases of leprosy there is produced a substance related to the reagin produced in treponematous infections, this method would be the most likely to demonstrate its presence and to eliminate false positives due to unrelated serum bodies. For comparison with this method, one hundred fifty sera were tested in parallel with an ordinary technic, which need not be described in detail. In this, both a plain and a cholesterinized alcoholic extract of lean beef heart were used.

The Kolmer antigen was used as recommended; namely, in a dose containing ten antigenic units, each unit one-thirtieth of the anticomplementary unit. The plain and cholesterinized alcoholic antigens of the ordinary technic were closely titrated and two and a half antigenic units were used which amounted, with the plain alcoholic antigen, to one-fourth of the anticomplementary unit, and with the cholesterinized, one-fifth. A closely adjusted antisheep hæmolytic system was employed. The hæmolysin used at the beginning of the work was a potent one, of a titer of 1 : 8,000. Later, the hæmolysin that we produced had a titer of only 1 : 2,000. Two units in 0.5 cubic centimeter were used. A 2 per cent suspension by volume of sheep cells was used as indicator, and special effort was made to have it with as little variation as possible during the course of the work. Pooled sera of not less than four guinea pigs, obtained on the afternoon before the test, were used for complement. Both the hæmolysin and the complement were titrated on the morning before setting up the test proper, the latter in the presence of the antigen. Sera not more than three days old were inactivated at 56° C. for fifteen minutes, and those over three days old, for thirty minutes. The sera were used in amounts of 0.1 cubic centimeter.

In the ordinary technic both the primary and the secondary incubations were carried in a water bath at 37.5° C., while with the Kolmer technic the primary incubation was done in the ice box for eighteen hours followed by five minutes in the water bath. The secondary incubation was in the water bath for one hour.

The readings with both methods were made after the tubes had stood in the ice box from two to three hours, to allow partial settling of the unhæmolyzed cells. Readings were recorded according to the method of Citron,[14] in which complete absence of

[14] Kolmer, J. A., Infection; Immunity and Biologic Therapy, 3d ed. W. B. Saunders & Co., Philadelphia, page 472.

hæmolysis is recorded as 4-plus and, in the weaker reactions, 75 per cent hæmolysis as 1-plus and less than this as plus-minus. It is to be noted that for the present purpose even reactions of the last degree are considered positive, in full realization of their doubtful significance, at least in the diagnosis of treponematous infections.

CASES EXAMINED

The five hundred cases here dealt with were individually unselected except that, the findings in lepra reaction proving of particular interest, as many cases of this as could be obtained during the course of the work (82 cases) were included. According to the classification used in the Culion Leper Colony, about 70 per cent were of the mixed type, about 20 per cent cutaneous, and about 10 per cent neural. Most of them (434 cases) had been treated with chaulmoogra-oil derivatives for two years or more; sixty-six were untreated new arrivals; fifty-nine cases were on the negative list (that is, they were clinically arrested and bacteriologically negative), and several of these had practically completed the two-year observation period after having become negative.

The total group includes two series. The first comprises three hundred cases under treatment by one of us (E.R.-P.), in all of which a careful physical and historical examination was made. The sera of one-half of this group were tested by both methods. In the second series, of two hundred sera, the Kolmer method alone was used. As these cases were under treatment by other physicians, only those showing any degree of fixation were examined by us for evidence of a treponematous infection. Reactions made at the request of the attending physicians on account of suspected luetic or frambœsial infection are not included.

RESULTS

The results of the reactions are summarized in Table 1. Of the first group (all specially examined clinically), thirty-two cases were suspected of suffering from yaws, and of these twenty-six, or 81 per cent, gave positive reactions. Eighteen were suspected of being syphilitic, and fifteen, or 83 per cent, gave positive reactions. In two hundred fifty, no evidence of either syphilis or yaws could be determined; eighteen of these (7.2 per cent) gave reactions that were positive to some degree.

In the second group, of two hundred cases, under the treatment by other physicians, twenty-six gave positive reactions

and were examined clinically by us. In ten a diagnosis of yaws could be made, and seven were diagnosed as syphilitic. The remaining nine patients gave neither history nor clinical signs of a treponematous infection.

TABLE 1.—*Incidence of the Wassermann reaction in lepers with and without clinical evidence of treponematous infection.*

Case groups.	Number.	Percentage of group.	Wassermann reaction.		
			Negative.	Positive.	Percentage positive.
Group 1: [a]					
Apparently uncomplicated	250	83.3	232	18	7.2
Yaws suspected	32	10.6	6	26	81.2
Syphilis suspected	18	6.0	3	15	83.3
Total	300		241	59	19.7
Group 2: [b]					
Evidence of yaws	10		0	10	
Evidence of syphilis	7		0	7	
No evidence of either			174	9	
Total	200		174	26	13.0
Grand total	500		415	85	17.0

[a] All cases examined clinically for evidence of yaws or syphilis.

[b] Only cases giving positive Wassermann reaction were examined clinically for treponematous infection.

Taking both groups together (totaling five hundred cases), eighty-five cases, or 17 per cent of the total, gave reactions that were positive in some degree; but fifty-eight, or 68 per cent, of these were in cases of known or suspected treponematous infection. Only twenty-seven more or less strongly positive reactions were in patients not under such suspicion. These will be discussed in detail.

Yaws group.—Of the forty-two cases suspected or diagnosed as suffering from yaws, thirty-six gave positive Wassermann reactions. Data on these cases are given in Table 2.

In Tables 2, 3, 4, and 5 the following abbreviations are used:

K = Kolmer antigen and technic.
P. A. = Plain alcoholic extract of beef heart. Ordinary technic.
Ch. A. = Cholesterinized alcoholic extract of beef heart. Ordinary technic.
M = Mixed.
N = Neural.
C = Cutaneous.
Sl = Slight.

Mod = Moderate.
Mkd = Marked.
Arr = Arrested.
0 = Not done.

TABLE 2.—*Cases of leprosy with clinical evidence of yaws.*

No.	Age.	Leprosy.				Wassermann reaction.			Remarks.
		Type.	Stage.	Duration.	Bacteriological examination.	K	P. A.	Ch. A.	
	Yrs.			*Yrs.*					
1	10	M	Sl	2	+	4 +	0	0	Active lesions.
2	26	M	Mkd	15	+	3 +	0	0	
3	22	M	Mod	8	+	3 +	0	0	
4	17	M	Mkd	11	+	1 +	0	0	Treated.
5	19	M	Mod	11	+	4 +	0	0	
6	25	M	Mod	7	+	1 +	0	0	
7	17	M	Mkd	6	+	4 +	0	0	Lepra reaction.
8	24	N	Mkd	13	+	4 +	0	0	Active lesions.
9	59	M	Mod	4	+	4 +	0	0	
10	18	M	Mod	10	+	4 +	0	0	
11	30	M	Mod	3	+	3 +	0	0	
12	22	M	Mkd	7	+	4 +	0	0	
13	14	M	Mkd	6	+	4 +	0	0	
14	35	M	Mkd	9	+	4 +	0	0	
15	17	M	Mkd	8	+	4 +	0	0	Lepra reaction.
16	26	N	Mod	11	+	4 +	0	0	
17	23	M	Mod	12	+	1 +	0	0	Treated.
18	24	M	Mod	14	+	3 +	0	0	
19	35	M	Mkd	12	+	2 +	0	0	Lepra reaction.
20	17	M	Sl	10	+	4 +	0	0	Treated.
21	23	M	Mkd	?	+	4 +	0	0	
22	22	M	Mod	5	+	4 +	0	0	
23	20	C	Mod	5	+	—	—	1 +	Treated.
24	19	M	Sl	3	+	4 +	3 +	4 +	
25	18	M	Mkd	8	+	2 +	—	3 +	
26	20	M	Mod	3	+	2 +	2 +	4 +	
27	26	M	Mkd	2	+	4 +	4 +	4 +	
28	25	M	Mkd	2	+	4 +	4 +	4 +	
29	31	N	Arr	21	—	4 +	4 +	4 +	
30	33	N	Arr	18	—	2 +	±	2 +	
31	52	N	Arr	24	—	4 +	—	4 +	
32	45	M	Sl	10	+	4 +	1 +	4 +	
33	50	M	Mkd	13	+	4 +	4 +	4 +	
34	31	M	Mkd	2	+	3 +	1 +	4 +	
35	11	M	Mod	4	+	—	—	2 +	
36	25	M	Mkd	3	+	2 +	—	3 +	
37	32	M	Mkd	6	+	—	—	—	Tertiary, treated.
38	51	M	Mod	3	+	—	—	—	
39	35	M	Mod	3	+	—	—	—	
40	24	N	Arr	14	—	—	—	—	Treated.
41	20	C	Mod	9	+	—	—	—	
42	8	C	Mod	3	+	—	—	—	

Six of the patients placed in this group yielded negative Wassermann reactions, either because of error in diagnosis or because the infection had been overcome. Two of these had received arsphenamine treatment. Three others of this group had received such treatment but still yielded weakly positive reactions; evidently, not enough time had as yet elapsed for the reagin to disappear completely. A point of interest is that in six cases there was a slightly greater degree of fixation with the cholesterinized than with the Kolmer antigen (Nos. 23, 25, 26, 34, 35, and 36), while no serum in this table shows the converse in this respect.

Syphilis group.—Twenty-five cases were suspected of being syphilitic. Twenty-two of these gave positive Wassermann reactions, including one plus-minus reading. Data on these cases are given in Table 3.

TABLE 3.—*Cases of leprosy with clinical evidence of syphilis.*

No.	Age.	Leprosy.				Wassermann reaction.			Remarks.
		Type.	Stage.	Duration.	Bacteriological examination.	K	P. A.	Ch. A.	
	Yrs.			Yrs.					
1	43	N	Arr	6	—	2 +	0	0	
2	34	C	Sl	5	+	2 +	0	0	
3	28	C	Mod	9	+	4 +	0	0	
4	64	M	Mkd	4	+	2 +	0	0	
5	31	M	Mod	10	+	4 +	0	0	
6	27	N	Mkd	10	—	4 +	0	0	
7	38	M	Mkd	18	+	3 +	0	0	Lepra reaction.
8	28	M	Sl	3	+	2 +	0	0	
9	25	M	Mod	4	+	3 +	0	0	
10	55	M	Mkd	15	+	3 +	0	0	
11	35	M	Mkd	9	+	2 +	0	0	Lepra reaction.
12	51	M	Sl	4	+	4 +	1 +	2 +	
13	42	M	Mod	5	+	4 +	4 +	4 +	
14	47	M	Arr	?	—	4 +	4 +	4 +	
15	23	C	Mod	10	+	4 +	1 +	2 +	
16	25	M	Mkd	5	+	4 +	4 +	4 +	
17	20	M	Mod	3	+	3 +	—	2 +	
18	27	M	Mod	15	+	4 +	4 +	4 +	Treated.
19	24	M	Mod	3	+	1 +	1 +	1 +	
20	34	M	Mod	1	+	3 +	—	±	Treated.
21	45	M	Mod	2	+	4 +	2 +	3 +	Lepra reaction.
22	44	M	Mod	9	+	—	—	—	
23	48	M	Mod	10	+	—	—	—	Treated.
24	38	M	Mod	9	+	—	—	—	
25	36	M	Mod	3	+	—	—	—	

One case (No. 23) that was negative had previously received antisyphilitic treatment. Two cases (Nos. 18 and 20), although they had been treated, were still positive. It is to be noted that, where differences in the degree of reaction are seen in this group, the Kolmer technic gives the higher degree of fixation (Nos. 12, 15, 17, 20, and 21. This is in contrast with the findings in the yaws group and will be referred to again.

Apparently uncomplicated group.—Of particular interest in the present connection are the cases in which positive reactions were obtained but in which no clinical evidence of complication by syphilis or yaws could be elicited. The data are given in Tables 4 and 5. It must be remarked that, in spite of lack of such evidence, treponematous infection cannot be definitely ruled out. Some of these patients were very ignorant and could not answer questions intelligently. Moreover, four of them were Moros from northern Mindanao, a region in which yaws is known to be prevalent. It is to be noted that of eighteen unselected Moros tested seven, or 39 per cent, were positive, and most of them strongly so—a much higher rate than in the total group.

Of these twenty-seven cases, the majority (sixteen) are classed as lepra reaction cases. As this condition will be discussed in the next section, only the remaining eleven (41 per cent of the group) will be considered at this point. In eight of these the Wassermann reaction was strongly positive. In each of the three weak reactions but one antigen gave any degree of complement fixation; in two instances this was extremely weak, and in all of them the reactions were negative on retest, though the patients had received no antitreponematous treatment. It is significant that, in all three, the extent of the actual leprotic lesions was slight and the disease was not active; it seems incredible that even this slight degree of binding could be ascribed to it, for in view of the other results it is to be expected that only extensive active leprosy can give positive results. It is therefore felt that these reactions cannot be considered as affording evidence of positive results from leprosy in its ordinary phases.

The remaining eight were strongly positive. Three have died, primarily of nephritis; two of these had marked cutaneous leprosy. Five received antitreponematous treatment after the test and three became negative, including two of those that died; the third one has recently become weakly positive again. The

TABLE 4.—*Patients without evidence of leprosy or yaws.*

[Without lepra reaction.]

No.	Age.	Leprosy.				First test.			Antitrepo-nematous treatment.	Retests.			Remarks.
		Type.	Stage.	Dura-tion.	Lepra reac-tion.	K	P. A.	Ch. A.		K	P. A.	Ch. A.	
	Yrs.			*Yrs.*					*Injections.*				
1	65	M	Mkd	9	None	4 +	4 +	4 +	7	—	0	0	Died. Nephritis.
2	45	M	Mkd	3	do	4 +	4 +	4 +	6	—	0	0	Do.
3	23	M	Mod	2	do	4 +	4 +	4 +	10	—	0	0	Insufficient treatment.
										2 +	—	±	
4	38	M	Mod	6	do	4 +	0	0	3	3 +	0	0	Do.
5	22	M	Mod	7	do	4 +	0	0	3	4 +	0	0	Do.
6	20	N	Neg	7	do	4 +	4 +	4 +	0	4 +	2 +	4 +	On "Negative List."
7	35	M	Mod	3	do	3 +	0	0	0	4 +	0	0	
8	60	M	Mkd	9	do	4 +	3 +	4 +	0	0	0	0	Died. Nephritis.
9	14	C	Sl	5	do	—	—	±	0	—	—	—	Original reaction doubtful.
10	14	M	Sl	1	do	—	—	2 +	0	—	—	—	Do.
11	30	M	Sl	13	do	±	0	0	0	—	—	—	Do.

other two had received but three injections when last tested and their reactions were still strong.

INFLUENCE OF LEPRA REACTION

Lepra reaction [15] is of particular interest to the clinician, and it is now being found to be so from the serological aspect. Because of this a disproportionately large number, totaling eighty-two, were tested. Twenty-three, or 28 per cent, gave positive findings. Of these but four were diagnosed clinically as syphilitic and three as frambœsial. (See Tables 2 and 3.) It would seem that such complications are not unusually frequent in lepra reactions seen here, so far as clinical evidence can show.

With further reference to the uncomplicated group giving positive Wassermann reaction (Table 5), it is striking that sixteen, or 58 per cent, were to be classed as lepra-reaction cases. In fourteen this condition actually existed at the time of the first test. The other two gave evidence of being in this general condition.[16] One had recently had it, and the other had it in the interval between the tests; in both the protein abnormality referred to persisted.

It is seen that of these sixteen cases only one (No. 16) gave a strong reaction (3-plus); this patient, a Moro, had been given three injections of neoarsphenamine when last retested and the reaction had become 4-plus.

The remaining fifteen cases gave weak reactions, and with at most two antigens when three were used. These results are markedly in contrast with those in the group of cases without lepra reaction discussed above. Retests were made on fourteen of these patients; the other one died of leprous cachexia due to the persistent reactions. Six were negative on retest, in four

[15] By lepra reaction we mean a rather ill-defined occasional phase in the course of leprosy, characterized by exacerbation of the old cutaneous lesions, with or without the appearance of new ones, such as macules, papules, and infiltrations that may later subside or remain as permanent lesions; there may or may not be fever, but this is usual in the more-marked degrees of the phenomenon. Other symptoms may accompany this reaction, such as malaise or neuritic or general muscular pains. The nature of this reaction is not well understood. While some consider that it is due to a temporary toxæmia, others are of the opinion that the disturbance is of anaphylactic nature. The actual exciting cause may be anything that lowers the resistance of the body, or treatment with the ethyl esters; the exciting factor is not always determinable.

[16] It may be stated here that work under way in the Culion laboratory shows that there is marked abnormality of the serum proteins in lepra reaction.

TABLE 5.—*Patients without evidence of syphilis or yaws.*

[With lepra reaction.]

No.	Age.	Leprosy.				First test.			Antitreponematous treatment.	Retests.			Remarks.
		Type.	Stage.	Duration.	Lepra reaction.	K	P. A.	Ch. A.		K	P. A.	Ch. A.	
	Yrs.			*Yrs.*					*Injections.*				
1	12	C	Mod	4	At time	±	0	0	0	—	0	0	Reaction subsided. Two retests.
2	28	M	Mod	10	do	1 +	—	1 +	0	—	0	0	Do.
3	26	M	Mkd	18	do	—	—	2 +	0	—	—	—	Do.
4	27	C	Mkd	8	do	1 +	±	2 +	0	—	—	—	Reaction subsided.
5	17	M	Mod	5	do	+	0	0	0	—	0	0	Reaction persists.
6	16	M	Mkd	9	do	1 +	0	0	0	—	0	0	Do.
7	48	C	Mod	6	do	1 +	—	2 +	0	—	—	—	Reaction subsided.
8	28	M	Mod	10	do	1 +	—	2 +	0	—	—	1 +	Reaction persists.
										±	—	2 +	
										±	—	±	
9	34	M	Mod	12	do	1 +	—	2 +	0	2 +	—	±	Reaction between tests; subsided.
10	25	M	Mod	13	Recent	1 +	0	0	0	—	—	2 +	Do.
11	23	M	Mkd	7	Later	—	2 +	3 +	0	±	—	2 +	Reaction between tests only; subsided.
12	13	C	Mod	6	At time	1 +	0	0	0	±	0	0	Reaction subsided.
13	29	M	Mkd	9	do	—	—	2 +	0	0	0	0	Died. Leprous cachexia.
14	59	C	Mkd	7	do	1 +	0	0	0	±	—	—	Reaction persists.
15	27	M	Mod	4	do	1 +	0	0	2	1 +	0	0	Two injections neoarsphenamine. Reaction subsided between retests.
										—	—	—	
16	13	M	Mkd	5	do	3 +	0	0	3	4 +	0	0	Two injections neoarsphenamine before retest. Reaction subsided.

after subsidence of the lepra reaction, and in the other two in spite of persistence of this condition. Eight remained positive; in five there was no clinical evidence of lepra reaction at the time of retest, but three had had a reaction in the interval between the tests. In the other three the condition still persisted. One of the patients with persistent Wassermann after subsidence of the lepra reaction was given two injections of neoarsphenamine and became negative.

INFLUENCE OF TYPE OF LEPROSY

Those who believe that the Wassermann reaction is positive in leprosy find marked differences between the different types of the disease, and invariably report higher incidence in the cutaneous and the mixed types than in the neural. We have found no relation with the clinical type. Of three hundred two patients whose clinical classification was recorded, two hundred twenty-three were of the mixed type, forty-six were cutaneous, and thirty-three were neural, most of these the late, "burned out" variety. The percentages of positives in these groups were 19.7, 17.3, and 18.2, respectively. The slightly greater proportion in the mixed group is apparently due to the relatively greater number of lepra-reaction cases among them.

INFLUENCE OF ANTILEPROSY TREATMENT

As stated above, Goodpasture found some differences in the incidence of the positive reactions in the treated and the untreated cases. This has not been our experience. Of the total of five hundred cases, sixty-six were new arrivals that had not received any antileprosy treatment; eleven of these were positive. The remaining four hundred thirty-four either were under antileprosy treatment or had received it; seventy-four gave positive reactions. The percentages, 16.7 and 17, are practically identical.

CHILDREN

In the first series there were forty-six children under 15 years of age. Of these, five gave positive reactions, two of which (Nos. 9 and 10, Table 4) were probably of no significance, thus leaving three cases, or 6.5 per cent. This is much lower than the general average, and is of particular interest because in marked contrast with the findings of Lloyd, Muir, and Mitra,[17] who found it positive in 81 per cent of the children examined by them.

[17] Ind. Journ. Med. Res. 11 (1923) 1.

EFFECTS OF ANTITREPONEMATOUS TREATMENT

As the effect of antitreponematous treatment furnishes important evidence with regard to the causation of positive Wassermann reaction in leprosy, the data available are collected here. Thirty-two positive cases were treated with neoarsphenamine and the reaction repeated one or more times. The rest were not treated, for various reasons, the most important of which is that the treatment is not without danger in lepers as seen in the Culion colony. The results of the tests, together with data on the number of injections and the time interval from the last injection to the time of taking the blood, are given in Table 6.

TABLE 6.—*Cases of leprosy, Wassermann positive, treated with neoarsphenamine.*

No.	Clinical diagnosis.	Before treatment.	Injections.	Time interval from last injection.	After treatment.
1	Yaws	4 +	3	1 year	—
2	do	3 +	3	8 months	—
3	do	4 +	6	do	3 +
4	do	4 +	5	do	±
5	do	3 +	5	6 months	—
6	do	4 +	4	4 months	2 +
7 [a]	do	4 +	6	3 months	4 +
8 [b]	do	4 +	7	do	4 +
9	do	4 +	2	do	±
10	do	3 +	4	do	1 +
11	do	3 +	7	do	—
12	do	4 +	3	do	—
13	do	4 +	7	do	—
14 [a]	do	4 +	8	2 months	3 +
15	do	2 +	5	do	—
16	do	1 +	4	do	—
17	Syphilis	4 +	5	6 months	—
18	do	2 +	8	4 months	—
19	do	2 +	4	do	—
20	do	4 +	8	do	—
21	do	4 +	4	3 months	—
22	do	4 +	2	do	—
23	do	4 +	4	do	1 +
24	do	2 +	6	2 months	—
25	do	3 +	3	do	—
26	do	4 +	3	do	—
27	do	4 +	3	do	—
28	do	2 +	3	6 days	—
29	?[c]	1 +	2	2 months	—
30	?[c]	4 +	7	do	—
31	?[c]	4 +	10	do	—
32	?[c]	4 +	6	4 months	—

[a] Active lesions of yaws healed as result of treatment.
[b] Chronic ulcerative yaws, healing.
[c] Gave neither history nor signs of syphilis or yaws.

Out of the thirty-two cases treated, the reaction was changed from positive to negative in twenty-three. In seven others it showed a greater or less diminution in strength; these were, with a single exception, cases of yaws, in which disease the reaction is known to disappear more slowly than in syphilis, as has been shown by Goodpasture and de Leon.[18] In only two cases did the strength of the reaction remain unchanged, but these cases were frank cases of yaws and the lesions have already disappeared.

During the first part of this work, as will be seen in Table 4, five cases that gave no history and showed no clinical evidences of syphilis or yaws gave complete fixation, with the three antigens used. However, syphilis could not be definitely excluded. Because of the degree of the reaction, we believe they were suffering from either syphilis or yaws. One case died before antitreponematous treatment was begun, and another was of a neural type and had been a negative leper for nearly two years. It is obvious that in this case the reaction could not have been due to the leprosy. In three cases antitreponematous treatment was given, and these cases gave negative results after a series of injections, which we consider a confirmation of our opinion as to the cause of the reaction in these cases.

DISCUSSION

It is evident from the findings presented that, if the Wassermann reaction is ever positive because of serum changes essential to leprosy itself, it certainly cannot be said to be so in the same sense that it is in syphilis and yaws. Clearly, it is usually negative and can have no diagnostic or prognostic significance. Most of the patients who gave positive Wassermann reaction also gave evidence, either physical or in their histories, of syphilis or yaws. Incidentally, the latter would appear to be considerably the more prevalent in the Culion Leper Colony. This is in conformity with the existing conditions in the Philippines; for, whereas syphilis is not common except in the larger cities, yaws is endemic and prevalent in many localities.

Analysis of the positive group without clinical evidence of syphilitic or frambœsial complication has convinced us that there are two reasons for such reactions; one is unrecognized syphilis

[18] Philip. Journ. Sci. 22 (1923) 221–231.

or yaws, the other lepra reaction. Of the eleven cases in the first group three gave very weak reactions that were probably of no significance, as they did not persist, and in these cases the leprosy was but slightly advanced. The remaining eight had strong reactions which we have come to believe due only to treponematous infection. The results of neosalvarsan treatment in certain of these cases tend to confirm this view, for that drug has little effect—at least, general—in leprosy, whereas it caused the disappearance or reduction of the Wassermann reaction in the cases treated.

Though most of the positive findings may thus be ascribed to treponematous infection, there remains a group of cases that seem to indicate that leprosy may of itself cause complement fixation in the Wassermann reaction, at least to some degree. All of these were in the condition known as lepra reaction. In patients presenting this phenomenon in a high degree there is marked clinical disturbance, necessitating hospitalization. Marked abnormality of the serum proteins is being found in work in progress in the Culion laboratory. Evidently there is some change, qualitative or quantitative, that tends to cause nonspecific binding of complement in the presence of lipoidal antigens. This has not occurred in most of the cases of lepra reaction as the tests have been carried out, and has not been strong when it has occurred in cases free from evidence or reasonable presumption of treponematous infection. Though this apparently nonspecific fixation of complement occurred, in one instance or another, with all the antigens used, it seems to be most frequent and strongest with the cholesterinized crude alcoholic. Why some cases give this fixation and others do not we are unable to say in the present state of our knowledge of leprosy, and particularly of this most interesting phase of the disease.

There remains, of course, the possibilty that an underlying latent treponematous infection exists in these cases, which is perhaps responsible for the lepra reaction. This seems very doubtful to us. In the first place, the fact that these positive reactions tend to disappear spontaneously with subsidence of the lepra reactions is evidence that they are dependent upon the changes in the balance between host and the infecting organism. Of the sixteen Wassermann-positive lepra-reaction cases without clinical evidence of treponematous complication, all but one gave weak Wassermann reactions. A treponematous

complication active enough to be responsible for the lepra reaction would be expected to give a strong Wassermann reaction (as in the other groups), at least in a fair proportion of cases. On the other hand, were these positive tests due to a "provocative" effect of the lepra reaction in latent treponematous infections, we would again expect a larger proportion of strong reactions than 1 out of 16 (considering here only the clinically uncomplicated group). It is true that one of these cases was given neosalvarsan and became negative, but it is not certain that he might not have become so had no such treatment been given.

Further evidence that leprosy itself has, with the exception noted, no influence on the reactions obtained is that the findings have no relation to type of case or to antileprosy treatment. Those who have reported the reaction as positive in this disease have almost invariably found the incidence higher in the cutaneous and the mixed cases than in the neural. This is not our experience, the figures for the three types being surprisingly similar. Nor does analysis of the data with reference to duration of the disease show any essential relation. Goodpasture's very interesting suggestion that antileprosy treatment may serve as a provocative measure could not be confirmed, for the percentages in the untreated and the treated groups were practically identical.

Again, the fact that the children gave relatively much fewer reactions is significant, for among them there were all degrees of the disease. We consider the lower rate due to the fact that they have had less opportunity for acquiring treponematous infection. It may be noted that yaws shows little, if any, tendency to become endemic at Culion, and the few acute cases that appear are treated.

A few observations with regard to the methods used may be recorded. Two cases (Nos. 9 and 10, Table 4) were negative with Kolmer's technic but showed fixation with the ordinary technic. This, coupled with differences of intensity of the fixation in cases of lepra reaction (Table 5), shows that the new method is distinctly less susceptible to slight nonspecific complement fixation than is the usual technic, particularly when an ordinary cholesterinized alcoholic extract is used as antigen.

In using the ordinary technic, we find that a very close titration of the cholesterinized extract for its antigenic unit is necessary. We have used two and a half antigenic units, which

gives a very slight excess of the antigen relative to the dose of both the complement and the hæmolysin. When the antigen was increased to one-third of the anticomplementary unit, a much larger percentage of fixations occurred—much larger than is the experience in nonlepers with this type of antigen. The tendency of the sera to fix complement in the presence of crude alcoholic extract of organs is evidently increased in leprosy.

Another point of interest, incidental to the main problem, is that, in those cases in which the positive reaction is due to yaws, the degree of fixation is apt to be greater with the cholesterinized alcoholic antigen than with Kolmer's. On the other hand, in those due to syphilis, Kolmer's antigen is apt to show a greater degree of fixation. So far as we are aware, this method has not been used in the study of yaws. While various authors have concluded that the Kolmer reaction is of superior practical specificity—as this term is used—in the serum diagnosis of syphilis, it is of interest that it should go so far as to give quantitative differences between the reagins of syphilis and of yaws. This seems to confirm the view of Castellani [19] that the reagins produced in the two diseases are different. Bowman [20] also came to the same conclusion, using plain alcoholic extract of guinea pig heart.

SUMMARY

The Wassermann reaction was made, using Kolmer's method, on the sera of five hundred lepers and, for comparison, about one hundred fifty of these were also tested by an ordinary method, using both plain and cholesterinized antigens. In the latter method it was found necessary to adjust the antigen dose closely, as an increase from the dose used, two and one-half antigenic units to four, resulted in an increased number of weakly positive or doubtful reactions.

The five hundred cases considered include sixty-six untreated new admissions, and cases that were under treatment at the time or that had been treated. Among the latter fifty-nine were negative and eighty-two were cases of lepra reaction.

Of the total group eighty-five, or 17 per cent, gave reactions that were positive in some degree, the doubtful plus-minus reactions being included. Of these, fifty-eight were in the group of sixty-seven cases that were under suspicion of yaws (42 cases) or syphilis (25 cases). In the remaining twenty-seven positive

[19] Journ. Hyg. Cambridge 7 (1907) 558.
[20] Philip. Journ. Sci. § B 5 (1910) 485–487.

cases neither history nor signs of yaws or syphilis could be elicited. Data on the clinically frambœsial and syphilitic groups are given.

The particularly interesting group without clinical evidence of treponematous infection is subdivided into those without and those with lepra reaction, eleven and sixteen cases, respectively. Of the former, eight gave strongly positive Wassermann reactions and of the latter but one. Further, the three weak reactions of the former group were in cases of slight leprous involvement, and the reactions were negative on retest. The one strong reaction in the latter group was in a Moro, particularly liable to yaws. These facts, and the results of antitreponematous treatment, strongly suggest that positive reactions were due to unrecognized syphilis or yaws.

The remaining fifteen weakly positive reactions in cases of lepra reaction were probably due to serum changes that occur in this condition, either peculiar to it or, more probably, particularly marked in it.

Our findings incidentally agree with those of others as to the sensitiveness of the Kolmer technic for the serum diagnosis of syphilis. Indeed, it seems to give less strongly positive reactions in yaws than does an ordinary cholesterinized antigen with the ordinary technic, thus affording further evidence that the reagins produced in these two diseases are not identical.

CONCLUSIONS

1. Our findings indicate that with Kolmer's and other refined methods the Wassermann reaction is negative in uncomplicated cases of leprosy in its ordinary phase.
2. Conversely, when the Wassermann reaction is clearly positive in cases of ordinary leprosy it has the same significance as in nonlepers.
3. In a certain proportion of cases of lepra reaction without evidence or presumption of treponematous complication weakly positive reactions are obtained. That such reactions are due to the same substance that is demonstrated in syphilis and yaws is highly improbable.

ACKNOWLEDGMENT

We are indebted to Dr. H. W. Wade, chief pathologist, for advice and for help in the preparation of this paper, and to Dr. John A. Kolmer for supplying us with the antigen and hæmolysin with which this work was begun.

STUDIES ON THE SEROLOGY OF LEPROSY, II

NITRIC ACID PRECIPITATION (BRUCK, MODIFIED)[1]

By H. W. WADE

Of the Pathological Section, Culion Leper Colony, Philippine Health Service

INTRODUCTION

Investigations on the serology of leprosy have, until recently, been conducted along two lines. One involves attempts to develop a specific reaction with leprosy antigens; the other has to do with the relation of the Wassermann reaction to the disease. The former problem is a most difficult one. The serology of infection with acid-fast bacteria in general involves peculiar difficulties, in that the antigens so far obtained have not permitted differentiation of members of the group. As regards leprosy there is, besides the close relation of the organism to that of tuberculosis, the handicap of the apparent non-cultivability of the causative agent, at least in its tissue form. A practical specific diagnostic test for leprosy seems not yet in sight.

The Wassermann reaction has not proved useful in this infection; for, though it has been generally understood that it is frequently positive, the reports have from the first been very discordant as regards the frequency. As the reaction has now been refined by syphilologists to increase its specificity or, rather, particularly for their purpose, positive reactions in leprosy uncomplicated by syphilis or yaws are at most infrequent. Mathis and Baujean,[2] using the technic of Calmette and Mossol, and recently Kolmer and Denney,[3] with the new technic of the former, find it regularly negative, as Yagley and Kolmer [4] have reported the Kahn precipitation reaction to be. Pineda,[5] applying

[1] Published with the approval of the Director of Health on recommendation of the Philippine Leprosy Research Board.

[2] Bull. Soc. Path. Exot. 8 (1915) 252.

[3] Arch. Dermat. & Syph. 8 (1923) 63.

[4] Arch. Dermat. & Syph. 8 (1923) 183–185.

[5] Antea, pp. 39–57.

Kolmer's technic in the Culion laboratory, has obtained results that agree with these reports in the main, though a small percentage of weakly positive reactions have been given by cases apparently free from syphilis or yaws, especially in "lepra reaction." It now seems clear that this question is of importance with reference to the treponematous infections rather than to the study of leprosy.

On the other hand, from the often reported occurrence of these—from the viewpoint of the syphilologist—false reactions in many cases of leprosy, particularly those with marked cutaneous involvement, it would seem that there is some peculiar serum change which, under some conditions, tends to bind complement in the Wassermann reaction. That the element involved is identical with the syphilitic reagin one would hardly suggest. It may be some factor or element irregularly present, or it may be something constantly present but only infrequently so to a sufficient degree to be demonstrable by this method.

That this general problem should be worked out need not be argued. There is urgent need of a test that will diagnose, or at least give presumptive evidence of, leprous infection in suspected cases, and also in contacts of known cases in order that by treatment latent infections may be prevented from evolving to the clinically positive stage. There is need of a test that may, by repeated application in cases under treatment, serve as a gauge of improvement. Finally, a test that would differentiate latency and actual cure in cases that have become clinically and bacteriologically "negative" would afford a far better basis of discharge than a fixed "negative period," which may be unnecessarily long in some cases and insufficient in others.

The problem is one that seems unlikely of ready solution, in spite of the advances that have been made. It would seem to call for much intensive work by a group of highly specialized investigators. From results obtained in the past it seems highly improbable that any established procedure or simple modification of such will suffice. It has, therefore, seemed profitable to approach the problem from another angle, to investigate certain of the physical and chemical peculiarities of the serum in leprosy.

The work to be reported in this and subsequent papers was begun along lines suggested by two recent reports. One is that

of Turkhud and Avari,[6] who found the formalin coagulation reaction, discovered by Gaté and Papacostas, to be positive in all cases of leprosy tested. The other is that of Schöbl and Basaca,[7] who found a distilled water globulin precipitation reaction, a modification of that of Klausner,[8] to be regularly positive. In line with these simple nonspecific reactions is the nitric acid precipitation test of Bruck, which has apparently not been applied in leprosy. The present report deals with the findings, with a slight modification, of this reaction in one hundred cases of leprosy.

THE NITRIC ACID REACTION

This reaction was described during the World War by Bruck[9] as possibly of value in diagnosing syphilis under conditions that would not permit the use of the Wassermann reaction. It is simple in principle, consisting of a rough determination of excessive (globulin) precipitate formed by nitric acid in dilute serum. It is not surprising that, as indicated by the several reports available to us, so nonspecific a reaction has met with disfavor as a means of diagnosing the presence of syphilitic infection.

Smith and Solomon[10] found disagreement with the Wassermann in 25 per cent of four hundred cases. In three hundred two nonsyphilitics 28 per cent gave doubtful or positive reactions. Stillians[11] had even poorer results, for in ninety-seven syphilitics in all stages there was 35 per cent disagreement with the Wassermann reaction. Of seventy-four nonsyphilitics 24 per cent gave positive reactions. Toyama and Kolmer[12] found that the reaction yielded 8 per cent false positives and was often negative when the Wassermann reaction was positive. Terada[13] found it to be somewhat less frequent than the Wassermann reaction in clinical syphilis (76 per cent of fifty-nine cases as compared

[6] Ind. Journ. Med. Res. **9** (1921–1922) 850.

[7] Philip. Journ. Sci. **25** (1924) 1.

[8] Wien. Klin. Wchnschr. (1908) 21, 214, 363, and Biochem. Ztschr. **47** (1912) 36 [cited by Kolmer, J. A., Infection, Immunity and Biologic Therapy. Philadelphia and London, 3d ed. (1923) 520].

[9] Münch. Med. Wochenschr. **64** (1917) 25 (cited).

[10] Boston Med. & Surg. Journ. **177** (1917) 321 (cited by Stillians and others).

[11] Journ. Am. Med. Assoc. **69** (1917) 2014.

[12] Journ. Cut. Dis. **36** (1918) 429.

[13] Kitasato Arch. Exp. Med. **3** (1919) 123.

with 86 per cent), and more frequent in nonsyphilitics (25 per cent of forty cases as compared with 12.5 per cent), but considers it of value when a more complicated test cannot be carried out.

Of interest in the present connection is the report of Corper and Fiala,[14] who tested the sera of two hundred five questionably or positively tuberculous and twenty-four nontuberculous persons. Of two hundred thirteen Wassermann-negative sera, one hundred thirteen (53 per cent) gave a positive Bruck reaction, most of them strong or fairly strong, a much higher percentage than obtained by others in nonsyphilitics. As for the relation to the stage of the tuberculous infection, it was more frequently positive among the moderately and far advanced (63 and 70 per cent, respectively) than among the nontuberculous (33 per cent), questionably tuberculous (46 per cent), and incipient (36 per cent) cases. No relation to the condition of the patient was to be seen. The authors could not see that the reaction gives any data of value.

A report by Mauchat, van Nitsen, and Walravens,[15] from tropical Africa, is also of interest. In thirty-two Europeans it was positive sixteen times; all of these were either syphilitic, with positive Wassermann reaction, or malarial or suspected malarial individuals. These positive reactions were all read as 1-plus. Of fifty-six Africans only two were negative, one with a phagedenic ulcer and the other with leprosy. In many the reaction was read as 2-plus, and in a few as 3-plus. They remark that the reaction is positive in syphilis and yaws when the Wassermann is positive, and generally in malaria though the Wassermann is negative. It is pointed out that practically all of the natives have chronic malaria.

TECHNIC

In the original technic 0.5 mil of serum is diluted with 2 mils of distilled water, and to this is carefully added 0.3 mil of a nitric acid solution of 1.149 specific gravity (approximately 25 per cent). In exactly ten minutes this is diluted with 16 mils of distilled water, and the tube is inverted three times to mix; ten minutes later the agitation is repeated. The test is read on the basis of the amount of undissolved precipitate, at the earliest a half hour later. As this is difficult to do before sedi-

[14] Am. Rev. Tuberc. 2 (1918-1919) 290.

[15] Compt. Rend. de la Soc. de Biol. 85 (1921) 720.

mentation has occurred, the tests are usually allowed to stand overnight.

At the beginning of this work efforts were made to make the test more precisely quantitative. However, it has become apparent that it has certain inherent weaknesses that, in view of the as yet indefinite significance of the results, do not recommend it for serious consideration; besides the differences in reaction of sera with similar globulin increases that follow from varying total protein contents, it is not free from technical error.

The formalin-coagulation reaction, though perhaps no more valuable or reliable, gives results that on the whole are similar, and it has the advantage of extreme simplicity and freedom from technical error. For this reason the technic used will be stated but briefly.

The sera were clear, or with at most but the faintest trace of hæmolysis, and were fresh and unheated. Some difficulty was met in determining the proper amount of acid solution, as the usual description of the standard solution is obviously incorrect. A solution was prepared [16] of which the standard quantity, determined with two known normal sera, was 0.25 mil. As each serum was tested by a titration series of four or five tubes, necessitating the use of one-half the usual amount of serum per tube, the acid solution was diluted one-half; this was found not to affect the results.

Three titration methods were tried, in which the variant was: (*a*) serum, (*b*) acid, or (*c*) final dilution. Of these, the first is probably the best, though the tests to be reported were done by the second. Better than either is a rough nephelometric determination of opacity. The sediments were examined after eighteen hours and read negative to 3-plus; the final record varied from negative to very strong, according to the number of tubes in the series showing precipitate and the amount of the precipitate.

FINDINGS

The results of the reaction with one hundred consecutive sera from lepers are given in Table 1 and, for comparison, those obtained with sixteen nonleprous controls. The cases were not selected as to type or extent of disease; as to complications, some of the sera were from hospital and clinic cases suspected of having syphilis or yaws.

[16] By Dr. G. A. Perkins, chief chemist of the Culion Leper Colony.

TABLE 1.—*Results of nitric acid precipitation reaction in sera of lepers and nonlepers.*

Case group.	Cases.	Degree of reaction.								
		Very strong.		Strong.		Moderate.		Weak.		Negative.
		Cases.	*P. ct.*	*Cases.*	*P. ct.*	*Cases.*	*P. ct.*	*Cases.*	*P. ct.*	
Untreated new cases	48	21	44	16	33	8	17	3	8	0
Treated clinic cases	41	3	7	20	49	14	34	4	10	0
Hospital cases [a]	11	3	27	8	73	0	------	0	------	0
Total	100	27	------	44	------	22	------	7	------	0
Negative lepers	10	1	------	6	------	1	------	2	------	0
Wassermann positive	21	8	38	11	52	1	5	1	5	0
Non-lepers:										
Professional staff	8	0	------	0	------	1	------	4	------	3
Laborers	8	0	------	2	------	4	------	2	------	0
Total	16	0	------	2	------	5	------	6	------	3

[a] Not suitable for antileprotic treatment.

Taking the lepers' specimens in total, seventy-one gave strong or very strong reactions, and twenty-nine were moderate or weak; none was negative. Considering the groups, there are decided differences in the distribution as regards degree of reaction. Of the newly arrived cases, not yet under antileprosy treatment, a relatively large number (44 per cent) gave very strong reactions, and only eleven (23 per cent) were moderate or weak. Of the cases under treatment only three (7 per cent) were in the very strong category, and eighteen (44 per cent) were moderately or weakly positive. The few reactions on lepers in the general hospital (not suitable for antileprosy treatment) were all strongly or very strongly positive.

Thirteen of the one hundred cases were on the "negative list;" that is, they showed no clinical signs of active leprosy and were bacteriologically negative. Such patients remain under observation and treatment for a further two years. The degree of reaction in the ten with negative Wassermann was fairly similar to that in the treated cases that are still positive. Evidently, the reaction does not tend to become negative rapidly in such patients.

The Wassermann reaction was performed (by Dr. E. V. Pineda) on all but two of the sera. In twenty-one inmates it was positive in some degree, apparently because of yaws or syphilis as a rule. Of these, all but two gave strong or very strong pre-

cipitation reactions; one, though from a probably syphilitic patient, with a 4-plus Kolmer Wassermann, was very weakly positive. On the whole, coincidence of these infections with leprosy apparently tends to increase the amount of precipitate, but this is so marked in most lepers that the difference is not great.

These results must be considered in comparison with the nonlepers. Comparatively few of these were available for examination. Of the eight specimens from the professional staff, only three were actually negative; four of the eight were weakly positive, and one was moderately strong. Of the eight laborers none was negative, and only two were weakly positive. In none of these nonlepers was the Wassermann reaction positive.

DISCUSSION

The results given by this reaction with the sera of nonlepers are of interest, because of the infrequency of negative findings. Even among the professional staff (most of them physicians), there was usually some excess of precipitate. As these individuals live in good circumstances, were apparently perfectly healthy and have remained so for nearly a year, one may doubt that a weakly positive reaction necessarily signifies the existence of a pathological condition. It would of course be difficult to determine clinically whether any particular individual is absolutely normal, but it may at least be said that if a positive reaction does depend upon an abnormality this may be very slight indeed.

It is not surprising that the laborers, whose grade of intelligence and mode of life are such as to make them more liable to infections of one kind or another, should give more frequent and stronger reactions. Still, the results seem excessive. It is to be remarked that the formol reaction has given decidedly fewer positive reactions in this nonleper group. I cannot ascribe this apparent oversensitiveness of the reaction to technic.

However this may be, it is evident that the reaction is strongly positive in the great majority of cases of leprosy uncomplicated by yaws or syphilis, indicating that there is as a rule a marked change in the serum in leprosy. The difference in the figures for treated and untreated cases are of some interest in the gross, indicating that treatment tends to reduce the abnormality on which this reaction depends. However, even in the negative cases tested such reduction had not gone very far.

215385——5

Bruck [17] classes the significance of the reaction among those that demonstrate globulin excess. Whether this change is very slight in some cases, as indicated by the weak reactions, cannot be said, without data as to the total protein content of the sera. That the conditions may vary otherwise than quantitatively in different sera is indicated by certain other observations; it does not seem profitable to discuss these in detail.

The findings herein reported are, so far as leprosy work is concerned, of interest as a further indication that there is usually a decided protein abnormality in lepers' serum. Because of the findings in nonlepers, particularly those of the laboring class, it is doubtful whether or not the test would be of value in diagnosis of suspicious cases or contacts, unless a marked degree of serum change occurs very early. As for prognosis, it would seem from the results in the small group of negatives examined that the reaction does not decrease sufficiently in accord with symptoms, at least in patients under continued treatment, to serve as a gauge of clinical improvement. The frequent positive findings in nonlepers indicates that it cannot serve as a basis for discharge.

SUMMARY AND CONCLUSIONS

The problem of the development of serological methods for establishing the diagnosis, prognosis, or cure of leprosy demands attention. That there are decided serological changes in this condition is evidenced by frequent positive Wassermann reactions as this test is usually done, and by the recent findings of Turkhud and Avari with the Gaté and Papacostas formalin coagulation reaction and of Schöbl and Basaca with the distilled water globulin precipitation test. No satisfactory specific reaction has been developed, and this is particularly difficult of realization because of the noncultivability of the organism and its evidently close relation to that of tuberculosis, which infection would have to be differentiated. The Wassermann reaction, at least in the forms most suitable for the diagnosis of syphilis or yaws, is of little if any value in leprosy, except for the diagnosis of these complications.

A study of the serum of leprosy has been undertaken by means of certain nonspecific tests and by other means, in the hope of throwing more light on the changes occurring in this disease. Results with the nitric acid reaction of Bruck, somewhat modified as to technic, are here reported.

[17] Deutsche Med. Wchnschr. 48 (1922).

Of one hundred lepers' sera tested, ninety-three were read as moderately to very strongly positive, and none was negative. Antileprosy treatment apparently reduces the degree of reaction, it being very strong in a much smaller proportion (7 per cent) of the cases that have been under treatment than in new untreated cases (44 per cent). The results in ten cases clinically and bacteriologically negative were essentially the same as in the treated cases, the explanation for which fact is not apparent. The reactions in twenty-one sera giving some degree of the Wassermann reaction was essentially the same as in the untreated group.

Of a group of sixteen nonlepers, only three gave negative reactions, these among the professional staff, while two (laborers) were strongly positive. The frequency of weak reactions in apparently healthy individuals leads to speculation as to whether these weaker reactions are due to any abnormality at all.

That this reaction is of no value in the diagnosis of a particular disease is obvious; that it does not depend upon the presence of syphilis (or yaws) alone, and does not have the significance of the Wassermann reaction, is again shown.

NATURE AND AVAILABILITY OF THE PLANT-FOOD CONSTITUENTS OF PHILIPPINE GUANO

By MARIANO TIRONA

Of the Division of Soils and Fertilizers, Bureau of Science, Manila

The use of fertilizer by the sugar planters of the Philippines, which is becoming more and more general since the operation of sugar centrals, has resulted in the intensive and extensive working out of already known guano deposits of the country and in the search for new ones. Thousands of tons of guano, made up mainly of the excreta of bats, are being mined every year, the greater part of which is sold to local manufacturers of fertilizer who use this material mainly as a source of phosphoric acid for their brands of fertilizer; the remainder is disposed of to farmers who apply it directly to the soil. The quantity of guano purchased by three fertilizer concerns alone amounted in 1924 to approximately 6,000 tons, and the prospect is that the amount will increase gradually in the next few years, since many farmers are beginning to realize the importance of manuring in relation to better crop production. This ever-increasing demand for local guano renders it important, therefore, that its nature and the availability of its plant-food constituents be known; it was with this end in view that the present investigation was undertaken. However, no attempt has been made to ascertain the different forms in which the various constituents may exist in the manure.

This investigation was conducted on twelve samples, taken from more than a hundred which were fairly representative of large shipments coming from different regions of the Archipelago, and which were submitted for analysis to the Bureau of Science, during the latter half of 1923 and the first half of 1924. The samples were ground to pass a 30-mesh sieve and were tested for moisture (H_2O), organic and volatile matter other than water, total nitrogen, nitrogen liberated by direct distillation with alkali, nitrogen as nitrates, water-soluble and insoluble nitrogen, total phosphoric acid, water and citrate soluble phosphoric acid, total and water-soluble potash, calcium oxide, and iron and aluminium oxides. The samples were also tested qualitatively for magnesium and sulphates, and all were found to contain small amounts of those substances.

Unless otherwise stated, the samples were analyzed as received.

ANALYSIS OF THE PRINCIPAL CONSTITUENTS

One gram of each sample was first heated to constant weight in an oven at a temperature of from 100° to 105° C., to ascertain the amount of moisture. It was then ignited to constant weight to determine the organic matter. Finally the residue was treated with 20 cubic centimeters of 1:1 nitric acid and 5 cubic centimeters of 1:1 hydrochloric acid, the mixture was kept boiling for over an hour, and then diluted and filtered, receiving the filtrate and washing in a volumetric flask, which was filled to the mark. Aliquot parts were pipetted out and analyzed according to methods adopted by the Association of Official Agricultural Chemists.[1] The total nitrogen was determined by the Gunning method, modified to include the nitrogen of nitrates.

TABLE 1.—*Principal constituents of Philippine guano.*

[The figures in the last four columns were obtained by digestion with strong acid.]

Sample No.	Moisture (H_2O). 100°–105°C.	Organic matter.	Total nitrogen (N).	Phosphoric anhydride (P_2O_5).	Potash (K_2O).	Calcium oxide (CaO).	Iron and aluminium oxides (Fe_2O_3, Al_2O_3).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
147366 [a]	33.85	34.90	4.69	4.20	0.43	13.30	10.63
150973 [b]	25.05	9.40	1.41	10.08	1.21	0.14	15.10
151016 [c] (71)	19.60	8.45	0.38	10.05	0.59	2.04	18.18
151016 [c] (72)	17.15	11.20	1.13	28.60	0.80	4.96	24.14
151025 [d]	30.40	18.45	1.22	11.78	0.77	7.86	7.78
151559 [e] (260)	21.23	11.27	1.07	6.51	1.10	1.02	11.73
151559 [f] (261)	29.20	9.45	0.97	7.44	1.02	0.73	6.94
151574 [g]	24.05	14.60	0.70	17.29	1.30	10.21	9.24
151676	16.60	19.40	2.38	5.94	0.34	1.46	11.27
151720 [h]	10.85	12.30	0.87	13.41	0.61	5.26	22.05
151749 [i]	7.38	7.65	0.94	20.69	0.95	1.90	18.49
151775 [j]	20.00	14.20	0.93	18.57	1.05	13.24	13.71

[a] Drawn from a shipment of 450 tons. The guano was obtained in Mataba, Masbate.

[b] Drawn from a shipment of 81.67 tons. The guano was obtained in Batangas.

[c] Drawn from a shipment of one carload. The guano was obtained in Iloilo.

[d] This guano was obtained in Marinduque.

[e] Drawn from a shipment of 95 tons. The guano was obtained in Batangas. Sample lost 15.59 per cent on air-drying.

[f] Drawn from a shipment of 24 tons. The guano was obtained in Batangas.

[g] Drawn from a shipment of 53 tons. The guano was obtained in Bohol.

[h] Drawn from a shipment of about 150 tons. The guano was obtained in Bohol.

[i] Drawn from a shipment of 40 tons. The guano was obtained in Iloilo.

[j] Drawn from a shipment of 417 tons. The guano was obtained in Masbate. Sample lost 18.16 per cent on air-drying.

[1] Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists, Revised, Washington, D. C. (1920).

The results of the procedure are shown in Table 1. From these, as well as from the analyses of a vast number of samples drawn from large shipments and forwarded to the Bureau of Science from different parts of the country, it is evident that the average Philippine guano is mainly phosphatic guano, its nitrogen ranging from a fraction of 1 to 2 per cent, its phosphoric acid from 6 to 20 per cent, and its potash from a fraction of 1 to a little over 1 per cent. That it is phosphatic in character is just what would be expected, if the climatic conditions of the country are considered. Recent guano deposits are generally richer in nitrogen, as shown by the occasional analyses of samples coming from them. As time goes on, however, the heavy tropical rains penetrate the caves and leach out the soluble constituents of the deposit, among which figure principally nitrogenous substances, leaving behind the less soluble phosphatic and other less soluble compounds. The deposit stays moist and wet for a long time thereafter, particularly the bottom layers. This results in the further decomposition of nitrogenous substances and subsequent loss of nitrogen by the volatilization of the products of disintegration, namely, carbon dioxide and ammonia, and in the percolation of the compounds of the latter together with whatever nitrates were formed by the nitrifying agencies, and with the readily soluble phosphorus, potassium, and other compounds. In consequence, the deposit tends to become more and more phosphatic, and the phosphorus is transformed into forms which are insoluble in water and in ammonium citrate. This transformation is the more complete the larger the amount of the iron and aluminium compounds that have found their way into the mass from the slowly crumbling structure of the cave. The invasion of the water from the sea, near which many deposits are situated, produces a similar effect, as does also the access of atmospheric moisture and dew, although to a much less extent.

AVAILABLE NITROGEN

By available nitrogen is understood here the fraction of the total nitrogen liberated by direct distillation of the sample, or of the water extract of the sample with an alkali, and such other fraction which, in the presence of a reducing agent, is set free by an alkali.

The purpose in undertaking the study of the availability of nitrogen in guano was twofold; namely, (*a*) to ascertain the quantity of nitrogen obtainable by treating the material and its

water extract with an alkali, and the quantity of the same element present as nitrates; and (*b*) to learn the effect on the solubility of nitrogen of allowing the material to stand wet through varying lengths of time at room temperature and, incidentally, to find out whether or not under this condition there would be any indication that ammonification and nitrification were taking place.

NITROGEN BY DIRECT DISTILLATION

About 250 cubic centimeters of water and 20 cubic centimeters of concentrated sodium hydroxide solution were added to 5 grams of the sample, and the mixture was boiled to distill off the ammonia, which was caught in a measured volume of 0.1 normal solution of sulphuric acid. The excess of the acid was titrated back against 0.1 normal solution of sodium hydroxide, and the nitrogen calculated as usual.

For the determination of nitric nitrogen, the residue of the preceding distillation was cooled off, then diluted to 250 cubic centimeters, and then 3 grams of Davarda alloy were added. After the effervescence had subsided, the mixture was gradually heated to brisk boiling, the whole operation lasting about four hours. The distillate was, as before, caught in a known volume of 0.1 normal solution of sulphuric acid, the excess of which was titrated back against 0.1 normal solution of sodium hydroxide. The results are given in Table 2.

TABLE 2.—*Nitrogen determined by direct distillation of the sample.*[a]

Sample No.	Total nitrogen (N).	Nitrogen in the form of ammonia, ammonium salts, simple amids, soluble proteids, etc.	Ratio of nitrogen from NH_3, etc. to total.	Nitrogen in the form of nitrate.	Ratio of nitrogen from nitrates to total.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
147366	4.69	0.88	18.76	1.37	29.21
150973	1.41	0.98	69.50	0.31	31.63
151016 (71)	0.38	0.09	23.68	0.08	21.05
151016 (72)	1.13	0.21	18.58	0.55	48.67
151025	1.22	0.22	18.03	0.32	26.23
151559 (260)	1.07	0.21	19.63	0.16	14.95
151559 (261)	0.97	0.41	42.27	0.17	17.52
151574	0.70	0.16	22.86	0.08	11.43
151676	2.38	0.19	7.98	0.24	10.08
151720	0.87	0.27	31.03	0.33	37.93
151749	0.94	0.77	81.91	0.03	3.19
151775	0.93	0.15	16.13	0.45	47.31

[a] The quantitative determination of nitrate nitrogen was preceded by a qualitative test with brucine, which test proved that all the samples contain this form of nitrogen.

WATER-SOLUBLE NITROGEN

Three 5-gram portions of each sample were placed separately in low, wide-mouthed bottles, and allowed to stand wet at room temperature for ten, twenty, and thirty days, respectively. The bottles were kept as far removed as possible from the ammonia of the laboratory and were covered with only a sheet of stiff paper in order to permit the free access of air. At the end of each of the periods the sample was transferred to filter paper and washed until the combined volume of the filtrate and the washing was 150 cubic centimeters. This quantity was diluted to about 250 cubic centimeters, and the nitrogen in it determined as above described.

TABLE 3.—*Water-soluble nitrogen dissolved by allowing the guano samples to stand wet for ten, twenty, and thirty days.*

Sample No.	Nitrogen (N) from ammonia, ammonium salts, simple amids, soluble proteids, etc.			Nitrogen (N) from nitrates.			Ratio of soluble nitrogen to total nitrogen.
	10 days.	20 days.	30 days.	10 days.	20 days.	30 days.	
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.* [a]
147366	0.51	0.54	0.56	1.41	1.30	1.34	40.95
150973	0.23	0.23	0.24	0.36	0.34	0.34	41.84
151016 (71)	0.02	0.01	0.01	0.06	0.08	0.08	21.05
151016 (72)	0.04	0.06	0.06	0.24	0.55	0.31	24.86
151025	0.05	0.05	0.05	0.31	0.28	0.29	29.50
151559 (260)	0.04	0.03	0.04	0.17	0.16	0.17	19.62
151559 (261)	0.06	0.06	0.06	0.20	0.18	0.17	26.80
151574	0.01	0.01	0.01	0.11	0.09	0.08	17.14
151676	0.04	0.08	0.04	0.21	0.20	0.20	10.50
151720	0.04	0.04	0.06	0.36	0.36	0.36	45.98
151749	0.58	0.57	0.53	0.02	0.02	0.02	63.83
151775	0.04	0.03	0.03	0.47	0.47	0.45	54.84

[a] The solubility for the ten-day period was used.

The figures in Table 3 bring out prominently the following facts: (*a*) The comparatively large amounts of nitrogen in water-soluble form; (*b*) the relatively large amounts of nitrogen (3 to 48 per cent of the total) in the nitrate form, which shows plainly the degree of nitrification that the products of fermentation or hydrolysis of the proteids and simple amids of the guano has undergone; and (*c*) the no less inconsiderable amounts of substances present which are soluble in water and which upon treatment with an alkali yield ammonia. These substances are easily available to plants, regardless of whether they are

organic or inorganic ammonium salts, simple amids, urea, guanidine, etc., and also regardless of whether they are directly absorbed by the plants[2] or have first to go through the process of ammonification or nitrification before they can be utilized as nutrient.

Comparing the quantities of nitrogen shown in Table 3 that might exist in the samples as ammonium salts, urea, guanidine, and other soluble simple amids and soluble proteids with the corresponding quantities of nitrogen shown in Table 2, it is seen that the former are only small fractions of the latter, the differences probably being due to the nitrogen occurring as proteids insoluble in water but decomposable into ammonia, amino acids, and other organic compounds by direct treatment with an alkali.

However, the existence of a considerable portion of nitrogen in the nitrate form is the important characteristic which distinguishes Philippine guanos from guanos found in other parts of the world (for instance, Chile and Peru) where the climate is warm and dry. In the guanos from countries with a warm, dry climate the proportion of nitrate nitrogen to total nitrogen is very small[3] because, owing to the poor supply of moisture, the process of fermentation and the process of nitrification can take place only very slowly.

As to the effect that wetting the material continuously through varying lengths of time has on the solubility of nitrogen, the figures in Table 3, taken in general, show that, under laboratory conditions, no increase could by this means be secured in the amount of water-soluble nitrogenous compounds yielding ammonia upon treatment with an alkali.

Despite the seeming inconsistency of the figures in the table, which inconsistency is attributable only to the defect inherent in the method of determination (for all the necessary precautions were taken to insure accuracy of results), they nevertheless apparently indicate that no ammonification or nitrification had taken place during the whole period of the experiment; therefore, it would seem that ammonifying and nitrifying bacteria were either absent or became extinct during the period of storage of the samples.

[2] U. S. Bur. Agr. Bull. 158 (1914) 20.

[3] Hall, Fertilizers and Manures. E. P. Dutton & Co., New York, 2d ed. (1921) 233.

AVAILABLE PHOSPHORIC ACID

The study of the availability of phosphorus in guano has involved a test of the solubility of the phosphoric acid content of the guano in neutral ammonium citrate, and also a test of its solubility in water, as this solubility is affected by the length of time during which the sample has been kept wet.

CITRATE-SOLUBLE PHOSPHORUS

The citrate-soluble phosphoric acid was determined by the method adopted by the Association of Official Agricultural Chemists, except that the water-soluble portion of phosphoric acid was extracted in a manner similar to that recommended by Caro and Larison,[4] which consisted in adding about 200 cubic centimeters of water to 2 grams of the sample, and allowing the mixture to stand for one and one-half hours and then filtering. The results are given in Table 4.

TABLE 4.—*Citrate-soluble phosphoric acid calculated as phosphoric anhydride* (P_2O_5).

Sample No.	Citrate soluble.	Ratio of citrate soluble to total.	Sample No.	Citrate soluble.	Ratio of citrate soluble to total.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
147366	3.06	72.85	151559 (261)	0.00	0.00
150973	0.70	6.94	151574	3.96	22.90
151016 (71)	2.74	27.26	151676	2.08	35.00
151016 (72)	0.08	0.28	151720	3.57	26.62
151025	1.79	15.19	151749	1.93	9.32
151559 (260)	0.00	0.00	151775	3.65	19.66

WATER-SOLUBLE PHOSPHORUS

Samples weighing 2 grams each were placed in wide-mouthed bottles and allowed to stand wet for two, five, nine, sixteen, and thirty days. At the end of each of these periods the phosphoric acid of each sample which passed into solution was extracted with 25 cubic centimeters of water (in 5-cubic-centimeter portions), and the liquid decanted through a filter. The residue in the filter was washed with 25 cubic centimeters of water in about 5-cubic-centimeter portions, and this washing added to the filtrate. The filter was then torn into small pieces and returned to the bottle. The phosphoric acid in the filtrate was determined as previously described for total phosphorus. The

[4] Ind. & Eng. Chem. 17 (1925) 261.

content of the bottle was again allowed to stand constantly wet, until the next period, and the phosphoric acid that passed into solution was extracted and determined as before. This process was repeated for all the remaining periods. The results are given in Table 5.

In testing for the solubility of phosphorus in water care was taken that the supply of the liquid should be the same throughout the experiment; it was never more than the quantity necessary to keep the samples constantly wet. It has been shown that in difficultly soluble phosphates the amount of phosphorus that passes into solution is in direct ratio to the quantity of the solvent used, and it was to forestall any error that might arise from the lack of uniformity in the quantity of water employed that this precaution was taken.

TABLE 5.—*Phosphorus dissolved by keeping the guano samples wet through different periods of time.*

[The figures represent percentages of phosphoric anhydride.]

Sample No.	Number of days.					Total dissolved in thirty days.	Ratio of total dissolved in thirty days to total.
	2	5	9 [a]	16	30		
147366	0.63	0.38	0.16	0.27	0.24	1.68	40.00
150973	0.03	0.03	0.05	0.06	0.08	0.25	2.48
151016 (71)	0.06	0.04	0.03	[b] 0.07	0.06	0.26	2.58
151016 (72)	0.31	0.12	0.07	0.21	0.18	0.89	3.11
151025	0.19	0.16	0.10	0.13	0.13	0.71	6.02
151559 (260)	0.02	0.01	0.02	0.04	0.04	0.13	1.99
151559 (261)	0.03	0.02	0.03	0.07	0.06	0.21	2.82
151574	0.19	0.16	0.06	0.09	0.13	0.63	3.64
151676	0.02	0.03	0.03	0.03	0.04	0.15	2.52
151720	0.05	0.04	0.04	[b] 0.05	0.07	0.24	1.86
151749	0.08	0.03	0.03	[b] 0.03	0.06	0.23	1.11
151775	0.25	0.18	0.09	0.28	0.36	1.16	6.24

[a] Extracted with 50 cubic centimeters of water in 10-cubic-centimeter portions. The residues were washed twice only. Sample 151016 (72) was extracted with 50 cubic centimeters in 25-cubic-centimeter portions.

[b] The residue on the filter was washed with 50 cubic centimeters in two portions.

The low availability of phosphorus in Philippine guanos, as demonstrated in Tables 4 and 5, taken together with the high percentages of the oxides of iron and aluminium shown in Table 1, is an indication that the element exists mainly as phosphates of those two metals. However, this is not surprising because, as above stated, the humid climate and the recurrent torrential rains that prevail in this country are the main agencies by which local guanos become impoverished of their prin-

cipal plant nutrients. Although the soluble phosphorus is not easily lost by leaching, it is nevertheless converted into insoluble forms, such as tricalcium phosphate and the phosphates of the metals aforementioned.

Coming now to the relation of the length of time the sample has been kept wet to the amount of phosphorus that passes into solution, the figures in Table 5, though they fail to indicate any such relationship, on the other hand, do point out the following facts: (*a*) That the water solubility of phosphorus in Philippine guanos is, in general, very small for a given period of time; (*b*) that the dissolving process of phosphorus is gradual and extends over a long period of time; and (*c*) that the amount of phosphorus that passes into solution is not in proportion to the organic-matter content of the samples, nor do the partial amounts dissolved bear any definite relation to the period of wetting.

This lack of relationship between the organic-matter content of the material and the amount of phosphorus being dissolved may perhaps be attributed to the possible absence of salts,[5] which in solution would hydrolize and, especially, to the great preponderance of the difficultly soluble phosphates of iron and aluminium that were formed during the leaching process that the deposit underwent in nature. Examination of columns 3, 7, and 8 of Table 1, in connection with column 7 of Table 5, seems to elicit the fact that those samples gave up comparatively good quantities of dissolved phosphorus which contain relatively small amounts of iron and aluminium but relatively large amounts of calcium and organic matter.

Whether guanos of the kind here studied would, when placed in the soil, readily give up their phosphoric acid, thus either changing the relation of the soil to the plant[6] or enabling the plant to use the phosphoric acid directly, is a question the answer to which is beyond the scope of this article; but there is abundant evidence, from practical use, to show that the application of such guanos is highly beneficial to plants.

AVAILABLE POTASH

To 2 grams of each guano sample, placed in a beaker, 200 cubic centimeters of water were added, and the mixture was allowed to stand for one and one-half hours and then filtered.

[5] U. S. Bureau of Soils Bull. 41 (1907) 50.
[6] U. S. Bureau of Soils Bull. 48 (1908) 8.

The potash in the filtrate and washings was then determined by the platinic chloride method, as adopted by the Association of Official Agricultural Chemists.[7] The results are given in Table 6.

TABLE 6.—*Water-soluble potash (K_2O) in Philippine guanos.*

Sample No.	Total.	Water soluble.	Ratio of water soluble to total.	Sample No.	Total.	Water soluble.	Ratio of water soluble to total.
	Per cent.	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*
147366	0.43	0.26	60.46	151559 (261)	1.02	0.15	14.70
150973	1.21	0.16	13.22	151574	1.30	0.03	2.30
151016 (71)	0.59	0.03	5.08	151676	0.34	0.09	26.47
151016 (72)	0.80	0.03	3.75	151720	0.61	0.07	11.47
151025	0.77	0.53	68.83	151749	0.95	0.57	60.00
151559 (260)	1.10	0.13	11.81	151775	1.05	0.11	10.47

The wide range of solubility in water of the potash in Philippine guanos, as shown by the figures in Table 6, indicates that potassium exists in different forms in the different masses; and since, in the case of plant nutrients, solubility and availability are identical, the inference is that no general conclusion can be established concerning the degree of availability of potash in local guanos. This statement is also true with reference to nitrogen and phosphorus.

SUMMARY

1. Philippine guanos are, in general, phosphatic guanos, the phosphorus existing mainly as phosphates of iron and aluminium. In freshly deposited guanos, however, the phosphorus exists mostly in immediately available form.

2. The water solubility of nitrogen in Philippine guanos—that is, the immediately available nitrogen—ranges from 16 to 60 per cent of the total, of which from 3 to 15 per cent may be considered as derived from ammonia, ammonium salts, simple amids, soluble proteids, etc., and the remainder from nitrates. An important characteristic of Philippine guanos is, therefore, the relatively large proportion of nitrogen that exists as nitrates.

3. Potash is invariably present in Philippine guanos in quantities generally not exceeding 1.5 per cent. From 3 to 68 per cent of this is immediately available to plants.

[7] Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists, Revised, Washington, D. C. (1920).

ADDITIONS TO OUR KNOWLEDGE OF THE BORNEAN FLORA, II

By Elmer D. Merrill

Of the University of California, Berkeley

The first paper of this series was published in 1922;[1] like its predecessor, the present paper contains descriptions of presumably previously undescribed plants and the records of a few species hitherto not definitely known to occur in Borneo; among the latter is a representative of the genus *Harrisonia*, a genus previously unknown from Borneo. Nine species in the genera *Castanopsis*, *Coelodepas*, *Canarium*, *Pentace*, *Grewia*, *Kayea*, *Ardisia*, and *Callicarpa* are herein described as new. The material on which this paper is based was chiefly supplied by Mr. D. D. Wood, in charge of the Forestry Service of the British North Borneo Government. The actual types of the new species herein described are deposited in the herbarium of the University of California and, so far as duplicate material is available, isotypes will be sent to several of the larger herbaria, including that of the Bureau of Science.

FAGACEÆ

Genus **CASTANOPSIS** Spach

Castanopsis pearsonii sp. nov.

Arbor circiter 25 m alta, ramis ramulisque glabris, teretibus, lenticillatis, ramulis circiter 3 mm diametro; foliis coriaceis, oblongo-ellipticis, integerrimis, 15 ad 20 cm longis, 6 ad 8 cm latis, perspicue acuminatis, basi late acutis, supra glabris, olivaceis, nitidis, subtus pallidioribus et minute furfuraceo-pubescentibus, nervis primariis utrinque circiter 12, curvatis, arcuato-anastomosantibus, subtus perspicuis; petiolo glabro, 1 ad 1.8 cm longo; floribus ignotis; infructescentiis spicatis, pedunculatis, circiter 20 cm longis, pedunculo elongato, glabro, lenticellato, circiter 4 mm diametro; involucris paucis, ut videtur plerumque 1 vel 2, subglobosis, circiter 5 cm longis et 6 cm diametro, crassis, intus densissime fulvo-hirsutis, extus dense

[1] Philip. Journ. Sci. 21 (1922) 515–534.

cinereo-pubescentibus, spinis numerosis crassis pubescentibus fasciculatis rigidis curvatis 4 ad 8 mm longis instructis, fasciculis in lineis subobliquis dispositis; glans plerumque 3, triangulari-ovoideis, acutis, 3-angulatis, castaneis, circiter 2.5 cm longis et latis, decidue fulvo-pilosis, basi solummodo affixis.

BRITISH NORTH BORNEO, Rayoh, *1151 D. D. Wood, col. Evangelista,* January 25, 1924, on forested ridges, altitude about 225 meters.

This species, dedicated to former Governor A. C. Pearson, C. M. G., of British North Borneo, is strongly characterized by its large, subglobose involucres which are divided vertically by four straight, spine-free sutures, the fascicles of stout, curved, glabrous-tipped spines being arranged in somewhat irregular, oblique lines, the spaces between the rows of spines being about as wide as the basal parts of the fascicles, the spines not concealing the entire surface of the involucres.

EUPHORBIACEÆ

Genus **COELODEPAS** Hasskarl

Coelodepas brevipes sp. nov.

Frutex inflorescentiis petiolisque exceptis glaber vel ramulis ultimis parcissime pubescentibus, ramis teretibus, tenuibus, pallidis; foliis brevissime petiolatis, chartaceis, in siccitate olivaceo-viridis, nitidis, subtus pallidioribus, oblongis ad oblongo-lanceolatis, 12 ad 18 cm longis, 4.5 ad 6 cm latis, basi obtusis ad rotundatis, subtus utrinque 1- ad 4-maculari-glandulosis, apice perspicue longe acute acuminatis, margine distanter crenatis, nervis primariis utrinque circiter 10, perspicuis, arcuato-anastomosantibus; petiolo 2 ad 3 mm longo, minute denseque tomentoso; stipulis lanceolatis, rigidis, acuminatis, 5 mm longis; inflorescentiis plerumque axillaribus, solitariis vel fasciculatis, minute subferrugineo-pubescentibus, 5 ad 7 mm longis, glomerulis ♂ 5- ad 10-floris, distantibus, sessilibus, 4 mm diametro; calycis leviter pubescentibus, lobis 3, ovatis, acutis, circiter 1 mm longis; staminibus 6, filamentis deorsum (1.5 mm) connatis, partibus liberis 0.5 mm longis; ovarii rudimentum bifidum; floribus ♀ paucis ad basin spicarum ♂, sessilibus, circiter 5 mm longis; sepalis circiter 9, lanceolatis ad oblongo-lanceolatis, acuminatis, 1 ad 2 mm longis, utrinque dense pubescentibus; ovarium 3-loculare, tomentosum, stylis flabellato-incisis.

BRITISH NORTH BORNEO, Kalumpang, *1291 D. D. Wood,* July 25, 1924, in forests at low altitudes.

A species manifestly allied to *Coelodepas wallichianum* Benth. of the Malay Peninsula, but differing in its thinner, differently shaped, slenderly and acutely acuminate leaves, shorter petioles, deeply lobed pistillate calyces and other characters. It is the second species of the genus to be recorded from Borneo. The pistillate flowers are few in number, solitary or in pairs at the base of some staminate inflorescences.

Genus **HOMONOIA** Loureiro

Homonoia riparia Lour.

Homonoia riparia LOUR., Fl. Cochinch. (1790) 637; PAX & HOFFM. in Engl. Pflanzenreich **68** [1] (1917) 114, *fig. 27.*

BRITISH NORTH BORNEO, Marudu Bay, *Mrs. E. Bateson 59,* June, 1923.

Curiously, this very widely distributed species has not hitherto been recorded from Borneo. It extends from India to Formosa through Malaysia to Timor and Celebes, always growing on the banks or in the beds of swiftly running streams.

BURSERACEÆ

Genus **CANARIUM** Linnæus

Canarium megalanthum sp. nov. § *Crassipyrena.*

Arbor circiter 15 m alta, perspicue ferrugineo-tomentosa, ramulis circiter 6 mm diametro; foliis circiter 40 cm longis, petiolis ferrugineo-tomentosis; foliolis plerumque 9, oblongis, chartaceis vel subcoriaceis, integris, in siccitate castaneis vel castaneo-olivaceis, subtus brunneis, breviter acuminatis, basi late rotundatis, plerumque inaequilateralibus, supra ad costa ferrugineo-tomentosis, subtus plus minusve ferrugineo-tomentosis; nervis lateralibus 13 ad 15, perspicuis, patulis vel leviter adscendentibus, circiter margine arcuato-anastomosantibus, reticulis subtus elevatis; petiolulis 4 ad 7 mm longis; inflorescentiis terminalibus, paniculatis, densissime ferrugineo-tomentosis, foliis subaequantibus, ramis paucis, inferioribus usque ad 9 cm longis; floribus longe pedicellatis, permagnis, circiter 1.5 cm longis, pedicellis crassis, usque ad 2 cm longis, bracteis ovatis ad oblongo-ovatis, crasse coriaceis, obtusis, utrinque dense tomentosis, circiter 1.5 cm longis et 1 cm latis; calycis lobis 3, crasse coriaceis, tomentosis, triangulari-ovatis, acutis, usque ad 1 cm longis; petalis 3, crassissime coriaceis, utrinque dense tomentosis, carinatis, orbicularis ad orbiculari-ovatis, obtusis, circiter 12 mm diametro; discus crassus, glaber, crasse coriaceus, circiter 7 mm diametro,

2.5 ad 3 mm altus; staminibus 6 in margine discum insertis, filamentis glabris, 3 mm longis, antheris leviter pubescentibus, anguste oblongis, filamentis subaequantibus; ovarium trigono-ovoideum, dense pubescens, 6 mm diametro; stigma capitatum, globosum, 3 mm diametro, longitudinaliter 3-sulcatum.

BRITISH NORTH BORNEO, near Weston, *No. 1213 D. D. Wood, col. P. Orolfo,* March, 1924, near the railroad line at low altitudes.

A species remarkable for its unusually large flowers, readily recognizable by this one character as well as by its dense ferruginous indumentum, few-flowered panicles, large bracts, and long stout pedicels. If properly placed within the section *Crassipyrena,* as the species are arranged by Engler, it comes nearest *Canarium balansae* Engl. but is remote from this particular species as it merely has in common with the latter the long-pedicelled flowers.

SIMARUBACEÆ

Genus **HARRISONIA** R. Brown

Harrisonia perforata (Blanco) Merr.

Harrisonia perforata (Blanco) MERR., in Philip. Journ. Sci. 7 (1912) Bot. 236; Enum. Philip. Fl. Pl. 2 (1923) 346.

BRITISH NORTH BORNEO, Lahad Datu, *Mrs. E. Bateson 33,* June, 1923.

Burma to southern China, the Philippines, and Java. The first representative of the genus to be recorded from Borneo; more commonly known as *Harrisonia bennettii* Hook. f.

TILIACEÆ

Genus **PENTACE** Hasskarl

Pentace laxiflora sp. nov.

Arbor circiter 8 m alta, ramis glabris, in siccitate rubro-brunneis, teretibus, ramulis circiter 2 mm diametro, dense cinereo-stellato-puberulis; foliis chartaceis ad subcoriaceis, oblongo-ovatis ad elliptico-ovatis, 6 ad 10 cm longis, 3 ad 4.5 cm latis, breviter acuminatis, basi plerumque rotundatis, tenuiter breviterque 3-nerviis, utrinque dense cinereo-stellato-puberulis, subtus pallidioribus; nervis primariis utrinque 4 vel 5, tenuibus, subtus distinctis, curvato-adscendentibus; petiolo puberulo, circiter 1 cm longo; paniculis dense cinereo-puberulis, laxis, usque ad 15 cm longis, ramis primariis patulis, inferioribus circiter 6 cm longis; floribus circiter 5 mm longis, pedicellis tenuibus, 2 ad 5 mm longis; calycis 3 mm longis, extus dense cinereo-puberulis,

lobis tubo aequantibus, ovatis ad oblongo-ovatis, acutis; petalis 5, spatulatis ad oblanceolatis, obtusis, 5 mm longis, glabris; staminoideis oblongis, 1.5 mm longis, crassis, pubescentibus; staminibus circiter 40, filamentis glabris, filiformibus, 3 ad 4 mm longis, plus minusve pantadelphis; ovarium oblongo-ovatum, pubescente, 3 mm longum, sulcatum, 5-loculare.

BRITISH NORTH BORNEO, Bundu, *No. 1804 D. D. Wood,* June 25, 1924, on slopes, with the Dusun name *takalis.*

A species apparently resembling *Pentace hookeriana* King which, however, has glabrous branchlets and leaves, much fewer stamens, and orbicular staminodes. It differs radically from *Pentace borneensis* Pierre in its fewer-nerved, glabrous leaves which have acute bases. Pierre's species was overlooked by me in preparing the manuscript of my Enumeration of Bornean Plants and is recorded below.

Pentace borneensis Pierre.

Pentace borneensis PIERRE, Fl. Forest. Cochinch. 2 (1888) sub *t. 151.*

SARAWAK, *Beccari 1261, 2663.* Known only from Borneo; the description is very imperfect.

Genus **GREWIA** Linnæus

Grewia pearsonii sp. nov.

Frutex erectus, 2 ad 3 m altus, partibus junioribus inflorescentiisque perspicue longissime ciliato-hirsutis; ramulis ultimis circiter 3 mm diametro, densissime breviter griseo-pubescentibus et pilis longis tenuibus patulis ferentibus; foliis lanceolatis ad oblongo-lanceolatis, chartaceis, 20 ad 35 cm longis, 5 ad 8 cm latis, integris, longissime tenuiter caudato-acuminatis, basi abrupte rotundatis, cordatis, 2 ad 4 cm latis, leviter inaequilateralibus, breviter 3-nerviis, supra in siccitate viridibus vel pallidis, subnitidis, costa perspicue hirsuta excepta glabris, subtus ad costa plus minusve pubescentibus et perspicue longe ciliato-hirsutis, nervis lateralibus parce ciliatis; nervis primariis utrinque circiter 12, subtus perspicuis, distantibus, curvatis, arcuato-anastomosantibus, reticulis primariis laxis, perspicuis; petiolo 6 ad 10 mm longo, dense pubescenti et perspicue ciliato-hirsuto; stipulis lineari-lanceolatis, circiter 2 cm longis, ciliatis; inflorescentiis paniculatis, terminalibus, circiter 10 cm longis, ramis paucis, ad 4 cm longis, omnibus partibus densissime breviter pubescentibus et longe ciliato-hirsutis; bracteis lanceolatis, acuminatis, longe ciliatis, usque ad 12 mm longis; bracteolis exte-

rioribus (3) ovatis, dense ciliatis, circiter 1 cm longis, saepe fissis, interioribus (3) oblongo-oblanceolatis ad ellipticis, obtusis, integris, pubescentibus, circiter 7 mm longis, 2 ad 4 mm latis; floribus 3, alabastro dense pubescenti, obovoideo; fructibus obovoideis ad subpyriformibus, haud stipitatis, glaberrimis, circiter 2.7 cm longis, 1.8 cm diametro, mesocarpo fibroso, endocarpo crustaceo, seminibus solitariis.

BRITISH NORTH BORNEO, Linkongan River, *No. 1216 D. D. Wood, col. P. Orolfo,* February 4, 1924 (type), in secondary forests, altitude about 60 meters; Kalumpang, *No. 1281 D. D. Wood, col. Puasa,* February 8, 1924.

A strongly marked species in the group with *Grewia omphacarpa* Miq. and *G. erythrocarpa* Ridl., characterized by its indumentum, consisting of dense short hairs and intermingled long spreading ciliate ones; its large, slenderly caudate-acuminate leaves which are abruptly rounded and cordate at the base; and its obovoid, glabrous, apparently fleshy, 1-seeded fruits. Named in honor of ex-Governor A. C. Pearson, C. M. G., of British North Borneo.

STERCULIACEÆ

Genus **PTEROSPERMUM** Schreber

Pterospermum diversifolium Blume.

Pterospermum diversifolium BLUME, Bijdr. (1825) 88.

BRUNEI, *D. D. Wood 1867, col. Goklin,* May, 1924. Indo-China and the Malay Peninsula through Malaysia to the Philippines and the Moluccas.

The form recorded from Borneo, on the authority of Miquel, as *Pterospermum acerifolium* Willd., an Indian species, is probably referable here, as Willdenow's species apparently does not extend to the Malay Archipelago.

GUTTIFERÆ

Genus **KAYEA** Wallich

Kayea acuminatissima sp. nov.

Arbor glaberrima, ramis teretibus, pallidis, circiter 3 mm diametro; foliis chartaceis vel subcoriaceis, oblongis, 14 ad 17 cm longis, circiter 5 cm latis, basi rotundatis ad subacutis, apice perspicue acutissime acuminatis, acuminis 1 ad 1.5 cm longis, apiculatis, in siccitate subolivaceis, utrinque nitidis, concoloribus, dense sed haud profunde subfoveolatis, nervis primariis utrinque circiter 15, tenuibus, curvatis, obscure arcuato-anastomosantibus;

petiolo circiter 1 cm longo; inflorescentiis axillaribus terminalibusque, 2 ad 6 cm longis, minoribus racemosis, majoribus paniculatis, ramis primariis brevibus, 3-floris; floribus albis, breviter (4 mm) pedicellatis, bibracteolatis, bracteolis oblongo-lanceolatis, acuminatis, circiter 1 mm longis; sepalis 4, exterioribus concavis, orbiculari-ovatis, circiter 4.5 mm longis, crassis, interioribus tenuioribus, laevis, orbiculari-obovatis; petalis 4, oblongo-ellipticis, 6 mm longis (immaturis); staminibus ∞, filamentis filiformibus, 5 ad 6 mm longis; stylo 6 mm longo. Fructibus ignotis.

BRUNEI, Tunggulian River, *D. D. Wood 1831, col. Goklin,* August 4, 1924, in swamps; locally known as *ladit.*

A species of the section *Eukayea,* well characterized by its very sharply acuminate leaves, the acumen being tipped by an almost spinelike apiculus.

MYRSINACEÆ

Genus **ARDISIA** Swartz

Ardisia subamplexicaulis sp. nov. § *Acrardisia.*

Frutex circiter 3 m altus, inflorescentiis minute puberulis exceptis glaber; ramulis teretibus, leviter lenticellatis, circiter 2 mm diametro; foliis alternis, chartaceis vel membranaceis, anguste oblongo-obovatis ad late oblanceolatis, integerrimis, sessilibus vel brevissime petiolatis, in siccitate olivaceo-viridibus, nitidis, utrinque concoloribus vel subtus paullo pallidioribus, 12 ad 22 cm longis, 5 ad 7 cm latis, apice acutis vel brevissime acuminatis, deorsum angustatis, basi abrupte rotundato-cordatis, 1 ad 2 cm latis, subamplexicaulibus, utrinque perspicue maculari-glandulosis; nervis primariis utrinque 15 ad 18, tenuibus, distinctis; inflorescentiis terminalibus, depauperato-paniculatis, circiter 10 cm longis, minute puberulis, ramis primariis paucis, 1 ad 1.5 cm longis, floribus subumbellatim dispositis; pedicellis 5 ad 7 mm longis, sursum leviter incrassatis; calycis circiter 4 mm diametro, lobis ovatis, acutis, glandulis paucis magnis instructis, circiter 1.5 mm longis, haud imbricatis, margine obscure ciliatis; corollae lobis oblongo-ovatis, subacutis, 3 mm longis, glandulis aurantiacis paucis magnis instructis; antheris ovato-lanceolatis, tenuiter acuminatis, 2.5 mm longis, connectivo perspicue atro-glanduloso; ovarium glabrum, atro-punctatum; stylis 2 mm longis, haud exsertis.

BRITISH NORTH BORNEO, Kalumpang, *D. D. Wood 1283, col. Puasa,* January 8, 1924, apparently from forests.

A species well characterized by its sessile or subsessile leaves which are narrowed below and abruptly rounded-cordate and subamplexicaul at the base, differing from *Ardisia caudifera* Mez in the above characters as well as in its much larger leaves, which are furthermore merely acute or very shortly acuminate, not caudate-acuminate.

VERBENACEÆ

Genus **CALLICARPA** Linnæus

Callicarpa woodii sp. nov.

Frutex circiter 2 m altus, inflorescentiis exceptis subglaber, ramis subteretibus, glabris, ramulis rotundato- 4-angulatis, 4-sulcatis, circiter 4 mm diametro, leviter cinereo-puberulis; foliis oppositis, subcoriaceis, in siccitate pallidis, oblongo-obovatis, 17 ad 30 cm longis, 7 ad 12 cm latis, distincte acuminatis, deorsum angustatis, basi acutis vel cuneatis, utrinque glabris et glandulosis vel subtus ad costa nervisque obscure puberulis, margine integris vel distanter obscureque denticulatis; nervis primariis utrinque 7 ad 9, curvatis, perspicuis, secondariis subparallelis; petiolo crasso, 5 ad 8 mm longo; cymis axillaribus, fasciculatis, sessilibus vel breviter pedunculatis, paucifloris, circiter 1.5 cm longis, dense sordide stellato-tomentosis; floribus 4-meris, pedicellis 2 ad 4 mm longis, calycis cupulatis, truncatis vel obscure et minute 4-denticulatis, longitudinaliter 4-nervosis, extus leviter stellato-pubescentibus, circiter 2.5 mm longis; corolla immatura 4.5 mm longa, 4-lobata, glandulosa; antheris 2.5 mm longis; fructibus obovoideis, 3.5 mm longis, glandulosis.

BRITISH NORTH BORNEO, Kampong Limbo, *1194 D. D. Wood, col. P. Orolfo,* August 4, 1924, in secondary forests, altitude about 50 meters.

A species well characterized by its glabrous, rather large, entire or very obscurely denticulate leaves, and by its short, fascicled, stellate-tomentose, few-flowered inflorescences which do not exceed 1.5 cm in length. It probably belongs in the general group with *Callicarpa basilanensis* Merr.

Callicarpa superposita sp. nov.

Frutex circiter 3 m altus plus minusve ferrugineo-villosus, indumento haud stellato; ramis ramulisque teretibus, ramulis circiter 2 mm diametro; foliis chartaceis vel membranaceis, lanceolatis, in siccitate olivaceis, opacis, 15 ad 20 cm longis, 4 ad 5 cm latis, longissime tenuiter caudato-acuminatis, deorsum

angustatis, basi rotundato-truncatis, circiter 1 cm latis, margine perspicue crenato-dentatis, dentibus plerumque apiculatis, utrinque plus minusve villosis, subtus glandulosis; nervis primariis utrinque 10 ad 12, tenuibus, perspicuis, curvato-adscendentibus; petiolo dense villoso, 5 ad 8 mm longo; cymis solitariis, pedunculatis, dichotomis, perspicue ferrugineo-villosis, 3 ad 5 mm supra axillis insertis, circiter 3 cm longis latisque, pedunculo 1 ad 1.5 cm longo; floribus numerosis, calycis 1 ad 1.2 mm longis, obscure 4-dentatis, extus leviter pubescentibus; corolla 2.5 mm longa, extus obscure puberula, subaequaliter 4-lobata; staminibus 4, filamentis 3 mm longis, antheris ellipsoideis, circiter 0.6 mm longis; ovarium glabrum, styli 5 mm longi; fructibus globosis, glabris, circiter 2 mm diametro.

BRITISH NORTH BORNEO, Simporna, *No. 1227, 1236* (type) *D. D. Wood, col. B. Evangelista,* July 14, 1924, growing at sea level.

A species readily distinguishable among the numerous species of this genus through its simple, not at all stellate indumentum, the weak, elongated, jointed hairs being either pale or ferruginous, as well as by its lanceolate, long caudate-acuminate leaves and its solitary cymes being inserted some distance above the axils. In aspect it resembles the Philippine *Callicarpa lancifolia* Merr. and *C. stenophylla* Merr., but is remote from both.

REVISION OF THE PHILIPPINE SPECIES OF THE GLENEINI (COLEOPTERA, LONGICORNIA)

By CHR. AURIVILLIUS
Of the Riksmuseum, Stockholm, Sweden

The following paper on the Gleneini of the Philippine Islands is based on very rich material sent by C. F. Baker, Los Baños, Luzon, and on the collection of the Natural History Museum (Riksmuseum) in Stockholm.

I am very greatly obliged to Mr. Baker and to Prof. Y. Sjöstedt, the keeper of the Entomological Department of the Riksmuseum in Stockholm, for their liberality and courtesy.

Tribe GLENEINI Lacordaire

This tribe of the Lamiinæ is very nearly allied to the Saperdini and differs only by having the middle tibiæ furnished with a distinct furrow or incision on the outer side below the middle.

A rare species from the Philippine Islands (Luzon), described in the year 1841 by Westwood as *Colobothea leucospilota* and hitherto referred to the genus *Glenea*, belongs in fact to a new genus of the Saperdini, and thus is excluded from the Gleneini. I have thought it appropriate, however, to describe that genus in this paper.

Four genera of the Gleneini are known from the Philippine Islands.

Key to the Philippine genera of Gleneini.

a^1. Elytra abruptly deflexed at the sides; upper surface separated from the deflexed side by one or two keels ending in the outer apical spine.
  b^1. Posterior tibiæ rounded .... **Glenea** Newman.
  b^2. Posterior tibiæ compressed .... **Chlorisanis** Pascoe.
a^2. Elytra rounded at the sides, without keels or with the keels not reaching the outer apical angle.
  b^1. Anterior claw of all the tarsi thickened and bifid, posterior claw simple. **Heteroglenea** Gahan.
  b^2. All the claws simple .... **Daphisia** Pascoe.

Genus GLENEA Newman

The genus *Glenea* is very rich in species, occurring from western Africa through southern Asia to China and Japan and all the

islands as far as New Guinea, New Britain, New Caledonia, and North Australia.

Not less than 51 (54) species are known from the Philippine Islands and nearly all are endemic.

The species have been distributed in four subgenera,[1] of which three are represented in the Philippine fauna.

Key to the subgenera of Glenea.

a^1. Prothorax widening toward the base with the sides entirely straight. Eyes not tumid, never more protruding than the temples. Subg. **Macroglenea** Aurivillius.

a^2. Prothorax tapering toward the base or at the most cylindrical, always more or less constricted at sides near the base. Eyes tumid.

- b^1. Scape without carina .... Subg. **Glenea** sens. str.
- b^2. Scape on anterior side with a distinct carina. Subg. **Stiroglenea** Aurivillius.

Subgenus Macroglenea Aurivillius

The head, seen from above, has a peculiar form, being broadest at base and more or less tapering forward. Tarsi short; first joint of hind tarsi only as long as or shorter than the second and third together.

Key to the species of Glenea Newman (subgenus Macroglenea Aurivillius).

a^1. Scutellum triangular. Elytra chalybeate with white-tomentose spots. **G. beatrix** Thomson.

a^2. Scutellum transverse, very broadly rounded at apex. Elytra with yellow stripes or yellowish tomentum.

- b^1. Prothorax with five yellow stripes. Elytra each with three yellowish stripes and a common sutural stripe; the discal stripe more or less abbreviated .... **G. kraatzi** Thomson.
- b^2. Prothorax above entirely clothed with a pale yellow tomentum and marked with two black dots. Elytra also yellow with some black dots and black humeral keel .... **G. sexpunctata** sp. nov.

Glenea beatrix Thomson.

Glenea beatrix THOMSON, Revue Zool. (3) 7 (1879) 4; RITS., Notes Leyden Mus. 3 (1893) 15; KUNTZEN, Ent. Rundschau 8 (1914) 31.

LUZON. MINDORO. BOHOL. MINDANAO.

Glenea kraatzi Thomson.

Glenea kraatzi THOMSON, Syst. Ceramb. (1865) 562.

Male, last ventral segment with a distinct keel near apex.

I wrongly identified this species with *G. regularis* in the Catalogue of the Lamiinæ. They are undoubtedly quite distinct,

[1] Aurivillius, Arkiv f. Zool. 13 (1920) 30–31.

and the latter species does not belong to the subgenus *Macroglenea.*

LUZON. "MINDANAO."

Glenea kraatzi Thomson var. **abbreviata** var. nov.

Differt vitta discali elytrorum brevissima, saepe triangulari.

PANAY. SIBUYAN.

Glenea (Macroglenea) sexpunctata sp. nov.

♀. Oculi supra approximati, vix tumidi; lobi inferiores genis haud duplo longiores. Tubercula antennigera approximata, sulco angulari separata. Caput pronoto angustius. Pronotum basin versus sensim latius, transversum, lateribus omnino rectis conicum. Scutellum late rotundatum. Elytra apice emarginata bispinosa costa humerali usque ad apicem distincta, infrahumerali obsoleta. Pedes mediocres; tarsi breves; articulus primus tarsorum posticoram 2° et 3° simul sumtis brevior. Unguiculi simplices. Virescente-nigra, tomento denso supra sulphureo, infra flavescente-griseo vestita; pronotum punctis duobus elytra punctis 4, duobus majoribus discalibus ante medium, duobus minoribus ad latera approximata pone medium, ornata. Prothorax utrinque vittis duabus, metasternum vitta laterali et abdomen utrinque maculis 4 denudatis aeneo-nigris praedita. Pedes cinereo-pubescentes. Antennae nigrae. Long. corporis 16 mm.

MINDANAO, Surigao, Surigao (*Baker*). Riksmuseum in Stockholm and Baker collection.

Very distinct in its coloration from all other species of the subgenus.

Subgenus **Glenea** Newman sensu str.

This subgenus comprises the majority of the species. The structural differences between the species are as a rule very slight, and I have therefore been compelled to found the smaller divisions mostly on markings and color.

The most important structural differences are the breadth of the front, the length of the cheeks, the relative length of the scape and the third joint of the antennæ, the length of the hind tarsi, and the development of the lateral keels of the elytra. The keels are as a rule two, joined to each other a little before the apex and running to the outer apical spine. The upper or humeral keel is always distinct at base, but obtuse or obsolete

near apex, more seldom very distinct and acute in its entire length. The inferior or subhumeral keel is wanting or obsolete at base but thence more or less distinct, seldom very obsolete or entirely wanting, in which case the humeral keel is very acute and distinct from base to apex.

The pygidium or last dorsal segment of the male is normally entire and rounded, but in a few cases excised at apex and the last ventral segment at the same time with a large lobe on each side.

Key to the species of Glenea Newman sensu str.

a^1. Derm brilliant blue, chalybeate, greenish or violaceous, ornamented with white spots. Hind tarsi elongate with the first joint longer than the second and third together. Front somewhat higher than broad. Femora rufous.

b^1. Tibiæ and tarsi black. Antennæ fuscous. Humeral keel of the elytra united near apex to the subhumeral keel. Last abdominal segment metallic blue .... G. **aphrodite** Thomson.

b^2. Tibiæ and tarsi testaceous. Antennæ brownish. Humeral keel of the elytra ending free near apex. Last abdominal segment rufous. Male, claws appendiculate. Female, claws simple.
G. **lepida** Newman.

a^2. Derm not metallic.

b^1. Prothorax and elytra with blue, greenish, or metallic markings, or at least the sides of the metasternum with metallic scales.[2] Hind tarsi long and slender, bluish white above; first joint longer than the two following together and four to six times as long as broad at apex. Scutellum blue or greenish. Elytra with apical blue or grayish spot.

c^1. Elytra without bluish spots, only with narrow sutural and humeral stripes. Femora testaceous .... G. **gracilis** Aurivillius.

c^2. Elytra each with one to six (isolated) blue or greenish spots.

d^1. Elytra with only one elongate, oblique discal spot near base. Sutural stripe abbreviated at base, humeral stripe abbreviated posteriorly and more or less thickened at end. Legs black. Pronotum with three bluish stripes. Female, third antennal joint silvery blue .... G. **artemis** Aurivillius.

d^2. Elytra each with two to six isolated bluish or greenish (rounded) spots.

e^1. Sutural stripe continuous from base to apex. The markings of the elytra grayish or only slightly bluish. Prothorax with three bluish stripes. Humeral keel of the elytra acute to apex, subhumeral keel behind middle wanting or very obsolete.

[2] Cf. also *G. tritoleuca* Aurivillius in which the front and the stripes of the prothorax sometimes are slightly greenish.

f^1. Elytra with abbreviated humeral stripe, a short discal stripe at base and two isolated spots, the first discal before middle, the second lateral behind middle. Male, femora testaceous.
G. pagana sp. nov.

f^2. Elytra each with two spots near base, two at middle and one lateral behind middle. Humeral stripe wanting, represented by the three lateral spots. Legs blackish, femora brownish at base.. **G. sordida Aurivillius.**

e^2. Sutural stripe wanting or only distinct behind the middle. Markings of the elytra blue, greenish, or margaritaceous.

f^1. Humeral stripe long and linear, ending somewhat behind middle and followed by a lateral spot.

g^1. Elytra with a linear discal stripe abbreviated at base and ending near middle; a small lateral spot at end of the humeral stripe .... **G. magica Thomson.**

g^2. Elytra without discal stripe, instead of with two spots, one before, one near the middle.
G. benguetana sp. nov.
? **G. lineella Thomson.**

f^2. Humeral stripe wanting, represented by two or three large spots.

g^1. Lateral stripes of prothorax straight and horizontal; dorsal stripe continuous; basal margin not blue between the stripes. Legs testaceous........... **G. exculta Newman.**

g^2. Lateral stripes of prothorax oblique, much lower at anterior end; dorsal stripe often interrupted in the middle; basal margin as a rule with blue or metallic girdle. Tibiæ and tarsi black with pale blue pubescence; femora reddish or black.. **G. suavis Newman.**

b^2. Prothorax and elytra with white, gray, yellowish, brown, or black markings.

c^1. Elytra with the subhumeral keel distinct and near apex united to the humeral keel, which is more or less obtuse near apex.

d^1. Antennal joints (8) 9 to 11 white or pale yellowish. Elytra without spots.

e^1. Elytra only with sutural and humeral stripes. Prothorax on each side only with a single free white stripe.
G. astarte Thomson.

e^2. Elytra also with a narrow and somewhat obsolete discal stripe. Prothorax on each side with two narrow grayish stripes.
G. quinquevittata sp. nov.

d^2. Antennæ not whitish at apex.

e^1. Hind tarsi long and narrow; basal joint longer than the two following joints together and four to six times as long as broad at apex.

f^1. Elytra with yellow or white spots without stripes. Legs testaceous. Antennæ brown or fuscous.

g^1. Elytra black. Prothorax and vertex with a single yellow stripe.

h^1. Elytra each with three yellow spots, one near base, one near middle, and the third apical.
G. concinna Newman.

h^2. Elytra each with two yellow spots, one near middle, the other apical .... **G. colenda** Thomson.

g^2. Elytra brown with the apical third black with two white spots. Vertex with two white stripes. Prothorax above with medial line and lateral series of three white dots.

f^2. Elytra at least with sutural stripe............. **G. lusoria** Pascoe.

g^1. Elytra with very broad orange yellow sutural stripe. Prothorax entirely clothed above with orange yellow tomentum without stripes. Legs black.
G. bangueyensis var. **nigripes** var. nov.

g^2. Elytra with sutural and humeral gray or yellow stripes; humeral stripe rarely dissolved in spots or obsolete.

h^1. Prothorax gray with black mesial stripe.
G. dido sp. nov.

h^2. Prothorax black with three pale stripes.

i^1. Elytra with a long and free discal stripe from base to beyond middle and free apical spot; stripes grayish .... **G. iligana** sp. nov.

i^2. Elytra without discal stripe or only with a short discal stripe at base.

j^1. Vertex with a single broad yellow stripe. Mesial stripe of prothorax broad and yellow. Elytra without free spots.

k^1. Sutural stripe strongly widened behind the scutellum to a squarish spot, thence constricted and narrow. Humeral stripe linear, abbreviated posteriorly. Femora reddish.
G. minerva Aurivillius.

k^2. Sutural stripe of uniform breadth throughout or gradually broader toward the base. Humeral stripe rather broad and nearly reaching the apex. Legs black .... **G. univittata** Aurivillius.

j^2. Vertex with two pale narrow stripes or without stripes. Elytra often with free spots or with a short transverse fascia at middle.

k^1. Elytra at base with abbreviated discal stripe; their markings grayish. Femora reddish. Male, pygidium excised at apex; last ventral segment cleft into large lobes. Female, third antennal joint entirely blackish.
G. fissicauda sp. nov.
G. lobata sp. nov.

k^2. Elytra without discal stripe; their markings white or yellowish. Sutural and humeral stripes very narrow, linear or obsolete; the latter sometimes dissolved in two or three spots or lines; no other markings or a transverse line at middle.

Male, last abdominal segment normal. Female, third antennal joint with a bluish white ring at apex .... **G. tritoleuca** Aurivillius.

e^2. Hind tarsi short and broad; basal joint triangular, shorter, or not longer than the two following joints together, at the most three times as long as broad at the apex.

f^1. Prothorax above nearly entirely yellow or orange.

g^1. Head and prothorax with fine black mesial line. Elytra above densely clothed with a yellow tomentum, shoulders and deflexed sides nearly glabrous and blackish. **G. humeralis** sp. nov.

g^2. Prothorax without mesial line; apical and basal margin narrowly black. Elytra black, each with three white stripes.. **G. flavicollis** sp. nov.

f^2. Prothorax striped above or entirely black.

g^1. Prothorax above at each side with a very broad white stripe and with a black mesial stripe, which is sometimes divided by a fine (interrupted) white line. Elytra black with sutural, humeral, and short discal stripes.

h^1. Stripes of the vertex parallel. Discal stripes of the elytra narrow and free.. **G. cylindrepomoides** Thomson.

h^2. Stripes of the vertex strongly divergent. Discal stripes of the elytra very broad and united to the base of the sutural stripe............................ **G. triangulifera** sp. nov.

g^2. Prothorax above green or greenish with three pale stripes, the mesial sometimes obsolete.............. **G. viridis** sp. nov.

g^3. Prothorax above black or brown with pale stripes or entirely black.

h^1. Elytra red-brown (at least before middle) with free white or yellowish spots or dots; humeral stripes wanting. Legs brown.

i^1. Apical part of elytra black with a transverse white spot behind middle and a large squarish white spot near apex; no stripes. Vertex with broad contiguous stripes. Mesial stripe of prothorax broad and white; sides white without free stripe. **G. caraga** Heller.

i^2. Elytra red-brown to apex.

j^1. Elytra without sutural stripe and apical spot. **G. samarensis** sp. nov.

j^2. Elytra with yellowish sutural stripe and apical spot. **G. referens** sp. nov.

h^2. Elytra black, blackish, or fuscous, rarely brown or yellowish in basal third, but in that case without spots or with only a transverse streak at middle.

i^1. Upper [3] lateral pale stripe of the prothorax, if present, nearly quite lateral, at its posterior end placed below the shoulder of the elytra and never in continua-

[3] If there are two lateral stripes.

tion with the discal stripe. Legs black. Antennæ entirely black.

j^1. Vertex with broad contiguous stripes. Prothorax with distinct stripes; the mesial stripe broad. Elytra with rather broad sutural and linear humeral stripes; discal stripes usually wanting. All the markings yellowish gray.

G. intermixta sp. nov.

j^2. Vertex with two narrow separate stripes or without stripes. Elytra without discal stripes.

k^1. Prothorax with three yellow stripes. Elytra with very distinct yellow or yellowish sutural and humeral stripes............ **G. commixta** Aurivillius.

k^2. Prothorax above and elytra black without markings or only with very fine and obsolete stripes.

G. maura Pascoe.

i^2. Upper lateral pale stripe of the prothorax nearly dorsal and posteriorly connected with the discal stripe of the elytra or reaching the middle of the elytra between scutellum and shoulders.

j^1. Femora reddish. Eyes very tumid. Elytra blackish without markings................. **G. niveopectus** sp. nov.

j^2. Legs black. Eyes slightly tumid. Prothorax and elytra with distinct pale stripes.

k^1. Discal stripes of the elytra long, at least reaching the middle or continued by a series of spots.

l^1. Discal stripes of the elytra straight, not curved or approaching the suture. Sutural stripe entire. Elytra without apical spot, only lined with white or yellow.

m^1. Discal stripes of the elytra thick and short, not reaching to the middle, but followed by a series of spots. All the markings of the upper side sulphur yellow.

G. flavotincta var. vel sp. nov.

m^2. Discal stripes of the elytra fine and linear, reaching to the middle or nearly to the apex. Markings gray or whitish.

G. albolineata Thomson.

l^2. Discal stripes of the elytra curved or oblique, approaching the suture. Elytra with apical spot and entire humeral stripe.

m^1. Elytra with distinct sutural stripe, which however does not reach the base. Discal stripes curved at base and before middle united to the sutural stripe, thence again free and reaching the apical spot. Markings gray or whitish.

G. curvilinea sp. nov.

*m*². Elytra without sutural stripe. Discal stripes oblique at base and nearly reaching the suture at middle, thence running close to the suture to apex. Markings of the upper side yellow.................. **G. regularis** Newman.

*k*². Elytra without discal stripes or with a very short oblique stripe at base. Female, apex of the third antennal joint white.

*l*¹. Basal fourth of the elytra entirely clothed with a brown or grayish brown tomentum without stripes or spots. Sutural and humeral stripes distinct behind that patch. Stripes of vertex and prothorax brownish.

G. palauensis Aurivillius.

*l*². Basal part of the elytra not clothed with a brownish tomentum.

*m*¹. Vertex black without pale stripes. Elytra with the derm reddish brown at base; humeral and sutural stripes very narrow or wanting; no other markings. Prothorax with three narrow whitish stripes.

G. basalis Aurivillius.

*m*². Vertex with pale stripes. Prothorax with distinct stripes. Elytra with the sutural and humeral stripes long and a short oblique discal stripe at base.

G. versuta Newman.

*c*². Elytra with the subhumeral keel entirely wanting, at least behind the middle, and the humeral keel very distinct and acute to the apical spine, rarely obtuse at apex.

*d*¹. Elytra with the subhumeral keel entirely absent and the humeral keel rather obtuse near the somewhat declivous apex. Body with sulphur yellow markings. Elytra without stripes. Hind tarsi very short.. **G. pulchella** Pascoe.

*d*². Subhumeral keel of the elytra wanting only behind the middle; humeral keel very acute at apex. Markings gray or white.

*e*¹. Prothorax black above with three whitish stripes, the mesial broad. Vertex with two contiguous pale stripes. Elytra black, above with a broad discal stripe from base to apex, but without sutural and humeral stripes. Hind tarsi very long; first joint longer than the two following together and five to six times as long as broad at apex.

G. bivittata Aurivillius.

*e*². Prothorax cinereous with two oblong black dorsal stripes or spots, reaching neither the apical nor the basal margin.

*f*¹. Elytra not black at apex and without white transverse band behind the middle, cinereous with four large black spots. Sides of prothorax cinereous without black spot. Legs brownish. Hind tarsi long.................. **G. cinerea** Thomson.

f[2]. Apical fifth of the elytra black, anteriorly limited by a transverse white band. Elytra from base to behind middle with humeral, discal (and sutural) grayish stripes. Sides of prothorax with a black dot. Legs black. Hind tarsi rather short.................................. G. colobotheoides Thomson.

Glenea aphrodite Thomson.

Glenea aphrodite THOMSON, Syst. Ceramb. (1865) 561.

LUZON, Laguna, Mount Banahao. MINDANAO.

Glenea lepida Newman.

Glenea lepida NEWMAN, Entomologist 1 (1842) 301.

LUZON. MINDANAO. BASILAN.

Glenea gracilis Aurivillius.

Glenea gracilis AURIVILLIUS, Arkiv f. Zool. 15 (1923) 37.

LUZON. MINDORO. LEYTE. SIARGAO. BUCAS. MINDANAO.

Glenea artemis Aurivillius.

Glenea artemis AURIVILLIUS, Arkiv f. Zool. 15 (1923) 37.

LUZON.

Glenea pagana sp. nov.

♂. Angusta, gracilis, fusca infra brunnea, infra omnino virescente-argenteo squamosa obsque maculis nigris, supra vittis maculisque griseis aut virescente-griseis ornata. Caput breve cum oculis tumidis pronoto latius, punctatum vittis duabus verticis viridibus ornatum; frons, genae et tempora tota virescentia. Oculorum lobi inferiores magni genis triplo longiores. Antennae ad basin late distantes, fuscae scapo plus minus rufescente. Prothorax subcylindricus prope basin leviter constrictus, punctatus, supra subnudus niger vittis tribus virescentibus, externis lateralibus. Scutellum obtusum vel quadratum, totum virideсquamosum. Elytra sublinearia, apice emarginato truncata, intus dentata, extus spinosa, costa humerali acuta, infra humerali obsoleta, praedita, vitta angusta continua suturali, vitta abbreviata discali ad basin, vitta brevi humerali nec basin nec partem tertiam apicalem attingente, macula discali ante medium, macula laterali pone medium maculaque apicali griseis ornata. Femora rufescentia; tibiae nigricantes; tarsi supra argenteo-grisei, articulos basalis posticoram 2° et 3° simul sumtis multo longior. Long. corporis 9 mm.

LUZON, Benguet, Baguio (*Baker*). Baker collection; Riksmuseum, Stockholm.

Perhaps the male of *Glenea benguetana* sp. nov.

Glenea sordida Aurivillius.

Glenea sordida AURIVILLIUS, Arkiv f. Zool. 15 (1923) 36.

LUZON, Nueva Vizcaya, Imugan.

Glenea magica Thomson.

Glenea magica THOMSON, Syst. Ceramb. (1865) 563.

MINDANAO. LUZON, "Manilla" (Thorey).

Glenea benguetana sp. nov.

♀. Nigra, femoribus rufis signatoris argenteo-viridibus ornata. Caput punctatum, breve, cum oculis pronoto latius, nigrum genis, temporibus infra, vitta utrinque frontis vittisque duabus postice approximatis verticis viridibus. Lobi inferiores oculorum genis plus duplo longiores. Antennae ad basin late distantes, nigrae articulis 5–11 albido-sericeis. Prothorax leviter transversus, prope basin constrictus, punctatus, fere nudus, niger vittis tribus angustis pectoreque albido-viridibus; vittae externae fere laterales. Scutellum obtusum omnino albido-viride. Elytra versus apicem modice angustata, apice emarginato-truncata et extus spinosa, costa infra humerali obsolete et postice fere deleta, a basi parte quinta apicali excepta rude punctata, in medio vitta humerali nec basin nec apicem attingente, pone medium vitta suturali singuloque maculis 4 viridibus (prima discali ante medium, secunda suturali prope medium, tertia pone medium laterali, quarta apicali) ornata. Pectus et abdomen viridi-squamosa, maculis magnis lateralibus denudatis nitidis nigris ornata. Tibiae et tarsi obscura argenteo-pubescentia; articulus basalis tarsorum posticorum 2° et 3° simul sumtis longior. Long. corporis 9–10 mm.

LUZON, Benguet, Baguio (*Baker*). Baker collection, and Riksmuseum in Stockholm.

Glenea lineella Thomson.

Glenea lineella THOMSON, Syst. Ceramb. (1865) 563.

MINDANAO. Unknown to me.

Glenea exculta Newman.

Glenea exculta NEWMAN, Entomologist 1 (1842) 302.
Glenea ? coryphaea THOMSON, Syst. Ceramb. (1865) 563.

LUZON, Laguna, Mount Banahao and Mount Maquiling.

Glenea suavis Newman.

Glenea suavis NEWMAN, Entomologist 1 (1842) 302.
Glenea decemguttata AURIVILLIUS, Arkiv f. Zool. 13 (1920) 33.

LUZON. SAMAR. SIARGAO. MINDANAO.

Glenea astarte Thomson.

Glenea astarte THOMSON, Syst. Ceramb. (1865) 562.

LUZON. NEGROS. MINDANAO. BASILAN.

Glenea lycoris Thomson.

Glenea lycoris THOMSON, Syst. Ceramb. (1865) 563.

MINDANAO. Not seen by me. = *G. astarte* ♀ ?

Glenea quinquevittata sp. nov.

Fusca elytris brunneis, supra pallide vittata, infra albo- vel cinereo-tomentosa; antennae nigrae articulis 9–11 albis; femora testacea, tibiae tarsique nigricantia. Caput breve, cum oculis tumidis pronoto latius. Frons subquadrata (♂) vel quadrata (♀), griseo-pubescens utrinque flavido-vittata. Genae albido-tomentosae lobis inferioribus oculorum vix (♀) vel multo breviores. Vertex vittis duabus parallelis ochraceis ornatus. Prothorax prope basin leviter constrictus, basin versus vix (♂) vel leviter angustatus (♀) vitta media lata ochracea et utrinque vittis binis angustis bene separatis griseis ornatus. Scutellum rotundatum ochraceum. Elytra punctata punctis apicem versus sensim evanescentibus, apice oblique emarginato-truncata angulo externo spinoso costis lateralibus apicem versus valde obtusis et obsoletis, brunnea vitta suturali vittisque utrinque binis (vitta discali tenui subundulata, postice obsoleta, vitta humerali latiore apicem fere attingente) griseis. Tarsi postici breves articulo primo 2° et 3° simul sumtis brevior. Long. corporis 10–12 mm.

MINDANAO, Butuan (*Baker*). Riksmuseum in Stockholm and Baker collection.

Nearly allied to *G. astarte* Thomson but differing in having a discal stripe on the elytra, two lateral grayish stripes on the prothorax and the dorsal stripe on the prothorax ochraceous.

Glenea concinna Newman.

Glenea concinna NEWMAN, Entomologist 1 (1842) 301.
Glenea severa THOMSON, Syst. Ceramb. (1865) 565.

LUZON.

Glenea colenda Thomson.

Glenea colenda THOMSON, Rev. Zool. (3) 7 (1879) 18.

MINDANAO. LUZON, "Manilla" (Thorey).

Glenea lusoria Pascoe.

Glenea lusoria PASCOE, Trans. Ent. Soc. London (3) 3 (1867) 405, nota.
Glenea bimaculata AURIVILLIUS, Arkiv f. Zool. 13 (1920) 34.

Philippines.

Glenea bangueyensis Aurivillius.

Glenea bangeyensis AURIVILLIUS, Arkiv f. Zool. 13 (1920) 35.

BORNEO. BANGUEY ISLAND.

Glenea bangueyensis Aurivillius var. **nigripes** var. nov.

A forma typica differt pedibus totis nigris genisque paullo longioribus lobis inferioribus oculorum triplo brevioribus. Long. corporis 12 mm.

NEGROS (*Baker*). Baker collection.

Glenea dido sp. nov.

♀. Nigro-fusca, infra albido-tomentosa, supra griseo-signata. Caput breve, cum oculis pronoto latius genis, temporibus, vitta utrinque laterali frontis vittisque duabus curvatis oculos cingentibus verticis griseis vel albidis. Prothorax latitudine basali fere longior pone medium leviter constrictus, dense punctulatus, griseo-pubescens vittaque media dorsali basin haud attingente nigra ornatus. Scutellum obtusum, nigrum macula apicali grisea. Elytra apicem versus angustata, apice emarginato-truncata, a basi usque ad quintam partem apicalem rude punctata costis lateralibus distinctis et ante apicem conjunctis, macula apicali vittisque binis latis (discali postice cum macula apicali conjuncta et humerali ante apicem desinente) ornata; sutura a basi ultra medium anguste nigra. Pedes flavescente-fusci; tarsi mediocres, articulus basalis posticorum 2° et 3° simul sumtis vix longior. Antennae latae fuscae. Long. corporis 11 mm.

MINDANAO, Port Banga. Riksmuseum in Stockholm.

Glenea iligana sp. nov.

♀. Nigra, supra albido-signata, infra dense cinereo-pubescens. Caput breve, punctatum, nigrum, genis, temporibus, vitta utrinque frontis vittisque duabus approximatis, parallelis, rectis verticis cinereis. Oculi tumidi; lobi inferiores genis vix sesqui longiores. Tubercula antennifera late distantia, parum producta. Scapus antennarum articulo 3° multo brevior. Prothorax punctatus, subquadratus, ante basin modice constrictus, capite vix angustior, vittis tribus angustis dorsalibus, plus minus interruptis punctoque laterali cinereo-albidis ornatus. Scutellum obtusum albido-pubescens. Elytra apicem versus modice angustata, apice recte truncata, bispinosa spina exteriore longiore, vitta angusta suturali, vittis ternis nec basin nec apicem attingentibus (prima discali, secunda humerali, tertia subhumerali) maculaque apicali albido-cinereis ornata; epipleura etiam ante medium albida; costae laterales distinctae, prope apicem obtusae et conjunctae. Tarsi postici elongati articulus basalis 2° et 3° simul sumtis multo longior. Abdomen utrinque maculis 4 obscuris fere denudatis praeditum. Long. corporis 13 mm.

MINDANAO, Lanao, Iligan (*Baker*). Baker collection.

Glenea minerva Aurivillius.

Glenea minerva AURIVILLIUS, Tijdschr. v. Ent. **65** (1922) 171.

PALAWAN.

Glenea univittata Aurivillius.

Glenea univittata AURIVILLIUS, Arkiv f. Zool. **15** (1923) 38, 40.

Glenea univittata ab. vinculata ab. nov.

Elytra ad basin vitta brevi discali instructa.

LUZON. MASBATE, Sorsogon, Aroroy. SIBUYAN. NEGROS.

Glenea fissicauda sp. nov.

Nigra, supra albido-vittata et maculata, infra griseo-pubescens aut albido-tomentosa; pedes rufi, tarsis fuscis. Frons griseo-pubescens utrinque albido-vittata, punctulata, in more latitudine altior, in femina lata, subquadrata. Genae moris lobis inferioribus triplo, feminae haud duplo breviores. Vertex albido-bivittatus, vittis parallelis. Prothorax subcylindricus, ante basin constrictus, leviter punctatus, albo trivittatus, vittis externis lateralibus, a supero vix aut salum ex porte discernendis. Scu-

tellum obtusum albido-tomentosum. Elytra apice recte truncata bispinosa spina suturali breviore costis lateralibus distinctis et prope apicem conjunctis, cinereo-pubescentia vitta suturali et utrinque vittis duabus albidis ornata, vitta discali saepissime abbreviata medium haud attingente, vitta humerali ante apicem desinente ibique plus minus incrassata, interdum interrupta linea media basin haud attingente et macula laterali indicata, macula apicali grisea. Tarsi breves, supra griseo-pubescentes; posticorum articulos primus duabus sequentibus simul sumtis haud vel vix longior. Vitta lateralis metasterni maculaque laterales abdominis fuscae. Long. corporis 11–12 mm.

♂. Pygidium apice profunde incisum. Segmentum ventrale ultimum infra fere ad basin fissum, lobis lateralibus maximis, latis, apice late oblique subtruncatis et longe pilosis. Paramera longe exserta, lanceolata, infra pilis longis vestita.

NEGROS, Cuernos Mountains (*Baker*). Baker collection; Riksmuseum in Stockholm.

This and the following species differ from all other forms in the formation of the last (visible) abdominal segment of the male. It is to be noted that similar very sharp sexual differences occur also in some species of the South American genus *Colobothea.*

Glenea lobata sp. nov.

Speciei praecedenti valde similis et affinis. Femina vix nisi elytris subnudis, fortius punctatis vittaque suturali latiore, mas pygidio apice minus exciso lobisque lateralibus segmenti ventralis ultimi apice late emarginatis et utrinque ad angulos productis differunt. Long. corporis 11–12 mm.

MINDANAO. SAMAR. NEGROS, 1 male (*Baker*). Baker collection; Riksmuseum in Stockholm.

Glenea lobata ab. (?) **biguttulata** ab. nov. (sp. ?).

Pronotum utrinque inter vittas dorsales guttis binis albis notatum.

BASILAN (*Baker*). Only a single male, Baker collection.

Glenea triotoleuca Aurivillius.

Glenea tritoleuca AURIVILLIUS, Arkiv f. Zool. 15 (1923) 38, 40.
Glenea tritoleuca Aurivillius var. *tripartita* AURIVILLIUS, Arkiv f. Zool. 15 (1923) 39.

MINDANAO. BASILAN.

Glenea humeralis sp. nov.

Nigro-fusca femoribus ad basin flavidis, supra ochraceo-, infra (flavescente) cinereo-tomentosa. Caput breve, cum oculis pronoto latius, ochraceo pubescens vitta frontis et verticis nigra genisque cinereis. Genae mediocres lobis oculorum parum breviores. Prothorax leviter transversus basin versus angustatus, ante basin leviter constrictus supra totus ochraceus linea tenue media basin haud attingente fusca ornata lateribus infra cinereis vitta nulla laterali. Scutellum obtusum ochraceum. Elytra apice recte truncata extus spinosa supra usque ad costam humeralem dense ochraceo-tomentosa, lateribus deflexis areaque subquadrata humerali denudatis nitidis brunneo-nigris, carinis lateralibus distinctis prope apicem conjunctis. Tarsi breves; posticorum articulus basalis 2° et 3° simul sumtis brevior. Long. corporis 11 mm.

POLILLO (*Baker*). Baker collection.

Resembles *G. sulla* Aurivillius from Borneo, but without the lateral black stripe on the prothorax and with the ochraceous humeral stripe of the elytra completely united to the discal area. Also the tarsi are shorter than in *G. sulla*.

Glenea flavicollis sp. nov.

♀. Nigra, supra albido-vittata pronoto fere toto aurantiaco, infra dense albo-pubescens vitta laterali, in ventre maculari denudata nigra ornata. Pedes cinereo-pubescentes. Antennarum articuli 1–3 nigri (reliqui desunt). Caput punctatum genis, temporibus vittaque utrinque frontis et verticis albidis; vittae verticis late separatae. Prothorax leviter transversus, supra, dense et laete aurantiaco-tomentosus margine apicali et basali anguste nigris plus minus albido pubescentibus, utrinque vitta infralaterali curvata nigra instructus. Scutellum late rotundatum, albido pubescens. Elytra a basi ultra medium rude punctata, deinde fere laevia vitta communi suturali vittisque binis bene definitis albidis ornata, vitta intermedia discali paullo pone medium desinente, vitta humerali in spinam exeunte et apice cum vitta suturali conjuncta; carinis lateralibus distinctis ante apicem conjunctis. Tarsi breves; articulus primus posticorum 2° et 3° simul sumtis brevior. Genae lobis inferioribus oculorum haud duplo breviores. Long. corporis 14 mm.

SIBUYAN (*Baker*). Baker collection.

Only a single female of this species is known to me. It differs from all other species of the genus in the color of the prothorax.

No punctures are visible on the upper side of the prothorax.

Glenea cylindrepomoides Thomson.

Glenea cylindrepomoides THOMSON, Syst. Ceramb. (1865) 564.

LUZON.

Glenea triangulifera sp. nov.

Nigra, supra flavo-albido-vittata, infra griseo- vel albido-tomentosa et nigro-maculata. Caput breve, cum oculis tumidis pronoto latius. Frons latitudine altior, utrinque late flavido-vittata, in medio nigro-vittata. Genae nudae nigrae (♀) aut tomentosae (♂). Tempora tomentosa. Vertex vittis duabus postice valde divergentibus flavidis, inter eas triangulariter niger. Prothorax albido-tomentosus vitta lata dorsali vittaque utrinque infra-laterali nigris. Elytra punctata, apice truncata et extus spinosa, carinis lateralibus distinctis ante apicem conjunctis, vitta lata suturali, vitta latissima et brevissima discali cum vitta suturali conjuncta et maculam basalem transversam formante vittaque humerali nec basin nec apicem attingente flavo-albidis ornata. Pedes fusci (♂) aut rufo-testacei (♀); tarsorum posticorum articulus basalis 2° et 3° simul sumtis haud longior. Long. corporis 9–12 mm.

MINDANAO, Bukidnon, Tangkulan. NEGROS, Cuernos Mountains (*Baker*). Baker collection.

Easily distinguished from all other Philippine species of the genus by the black dorsal stripe of the prothorax and the broad black triangle of the vertex. The markings of the elytra nearly agree with those of *Glenea minerva* from Palawan.

Glenea viridis sp. nov.

Viridis, opaca (haud metallica) supra albido-vittata, infra dense albo-tomentosa; antennae apicem versus nigricantes; pedes pube tenui cinerea vestiti, femora ima basi testacea. Frons et vertex bivittata. Genae et tempora albida. Prothorax 4-vittatus, vitta superiore latiore. Scutellum obtusum, viride. Elytra apice emarginata et extus spinosa utrinque bicarinata, carinis postice conjunctis et in spinam exeuntibus, vitta suturali (interdum obsoleta) vittisque ternis (discali abbreviata, humerali lata apicem versus dilatata, infrahumerali tenui in mare fere nulla) albidis ornata. Tarsi breves, posticorum articulas primus 2° et 3° simul sumtis brevior. Long. corporis 11–13 mm.

♂. Metasternum in medio foveis duabus contiguis dense fulvo-tomentosis impressum.

SAMAR. MINDANAO (*Baker*). Baker collection; Riksmuseum in Stockholm.

The only species known with a green body.

Glenea caraga Heller.

Glenea caraga HELLER, Philip. Journ. Sci. 19 (1921) 541, t. 2, f. 3.

MINDANAO. SAMAR.

Glenea samarensis sp. nov.

♀. Brunnea, supra vittis et maculis flavido-tomentosis, infra tomento flavescente vestita. Caput cum oculis pronoto vix latius. Frons quadrata griseo-pubescens, utrinque flavo-vittata; genae griseae, mediocres, lobis oculorum haud duplo breviores; tempora flavida; vertex vittis duabus parallelis flavidis. Prothorax subquadratus, prope basin constrictus, flavido-trivittatus vittis lateralibus latis, inter vittas discrete punctatus. Scutellum late rotundatum, totum flavidum. Elytra apicem versus modice angustata, apice late truncata, bispinosa spina externa elongata, carinis lateralibus distinctis postice obtusis, prope apicem conjunctis, maculis quaternis (prima discali prope basin elongata, secunda fere in medio ad suturam approximata, tertia pone medium prope carinam humeralem rotundata, quartaque parva laterali prope apicem) punctaque uno alterave flavidis ornata. Antennae fusco-brunneae. Pedes brunnei tenuiter cinereo-pubescentis; tarsi breves, posticorum articulus basalis 2° et 3° simul sumtis brevior. Abdomen maculis trigonis lateralibus albo-tomentosis, praeterea griseo-pubescens. Long. corporis 13 mm.

SAMAR (*Baker*). Baker collection.

A single female only.

Glenea referens sp. nov.

♂. Brunnea capite et pronoto nigricantibus, supra vittis maculis flavidis ornata, infra albido-tomentosa. Frons latitudine altior albido-tomentosa vitta media angusta fusca. Genae subnudae, lobis oculorum quadruplo breviores. Tempora flavida. Vertex vittis duabus bene separatis flavidis. Caput breve cum tumidis pronoto latius. Prothorax subcylindricus, latitudine basali longior lateribus leviter convexis, prope basin paullulum constrictus, vitta dorsali vittaque utrinque laterali latissima coxas fere attingente flavidis ornatis. Scutellum subtruncatum, totum flavidum. Elytra fere ad apicen rude, ad basin foveatim punctata, apice emarginato-truncata angulo suturali dentato, externo

spina brevi ornato, carinis lateralibus distinctis prope apicem conjunctis praedita, vitta suturali postice in maculam apicalem dilatata maculisque quaternis rotundatis (prima discali prope basin, secunda parva laterali ante medium, tertia fere in medio vittam suturalem tangente, quarta minore laterali pone medium) flavido-tomentosis ornata. Corpus infra in medio pallidius, abdomen maculis lateralibus brunneis instructum. Tarsi breves, posticorum articulus basalis 2° et 3° simul sumtis haud longior. Antennae apicem versus infuscatae. Long. corporis 11 mm.

MINDANAO, Lanao, Kolambugan (*Baker*). Baker collection.

Nearly allied to *G. samarensis,* but probably not the male of that species, the elytra being more strongly punctured and having a distinct sutural stripe, an apical spot, and differently arranged markings. A small yellowish stain at base between scutellum and the shoulders.

A female specimen from Luzon, which differs only by having the front broader, subquadrate with broad medial black stripe, longer brown cheeks, much smaller elytral spots, but these arranged exactly in a similar way, and the ordinary sexual markings, may be the true female of *G. referens.*

Glenea helleri Aurivillius.

Glenea helleri AURIVILLIUS, Cat. Col. 74 (1923) 506.
Glenea scalaris HELLER, Philip. Journ. Sci. 19 (1921) 541, t. 2, f. 4.

LUZON. Not seen by me.

Glenea intermixta sp. nov.

Nigro-fusca (elytris interdum brunneis, immatura?), supra albo-vittata, infra griseo- et albido-tomentosa femoribus ad basin rufis. Caput punctatum cum oculis tumidis pronoto latius. Frons latitudine altior, in medio subnuda, utrinque flavescente vittata. Genae tenue pubescentes, lobis inferioribus oculorum parum (♀) vel plus duplo breviores. Vertex vittis duabus omnino contiguis antice inter antennal divergentibus ornatus. Antennae totae fuscae vel fusco-brunneae. Prothorax subcylindricus vitta lata dorsali vittaque angusta laterali infra pube cinerea, determinata albis instructus. Scutellum obtuse rotundatum, dense albo-tomentosum. Elytra ante medium fortius punctata, apice truncata et extus spinosa, carina humerali usque ad spinam acuta et continua, carina subhumerali obtusa ante apicem omnino evanescente, vitta lata suturali saepissime in medio fasciola transversa connexa vittaque tenui humerali nec basin nec apicem attingente albidis ornata, inter-

dum etiam vitta brevi discali ad basin instructa. Pectus et abdomen maculis denudatis fuscis praedita. Tarsorum posticorum articulus basalis 2° et 3° simul sumtis haud (♀) vel parum (♂) longior. Long. corporis 9–12 mm.

MINDANAO, Zamboanga, Dapitan, Iligan. BASILAN (*Baker*). Riksmuseum in Stockholm and Baker collection.

Allied to *Glenea commixta* Aurivillius and *univittata* Aurivillius, but differing in having the humeral keel of the elytra sharp to the apex and the subhumeral keel disappearing before apex. The stripes of the upper side are white or whitish, rarely yellowish.

Glenea commixta Aurivillius.

Glenea commixta AURIVILLIUS, Arkiv f. Zool. 15 (1923) 37, 40.

MASBATE, Sorsogon, Aroroy, Masbate. SAMAR.

Glenea commixta ab. (var. ?) **fasciola** Aurivillius.

Glenea commixta ab. (var. ?) *fasciola* AURIVILLIUS, Arkiv f. Zool. 15 (1923) 38.

MINDANAO.

Glenea maura Pascoe.

Glenea maura PASCOE, Trans. Ent. Soc. London (3) 3 (1867) 405, nota.

MINDANAO.

Glenea niveopectus sp. nov.

♂. Nigro-fusca, supra fere unicolor infra dense niveo-tomentosa utrinque maculis 4 parvis lateralibus denudatis abdominis brunneis. Caput breve cum oculis tumidis pronoto multo latius. Frons quadrata, punctata, cana, utrinque albido-vittata. Genae et tempora albido-tomentosa; genae lobis oculorum duplo breviores. Antennae totae nigrofuscae; scapus articulo tertio haud brevior. Prothorax subquadratus, supra nigro-fuscus, punctulatus lineis tribus, externis obsoletis, pallidis ornatus, utrinque in lateribus omnino niveo-tomentosus absque vitta. Scutellum latum, obtusum, nigrum linea tenui media alba. Elytra tota nigro-fusca seriatim punctata, apice suboblique truncata angulo suturali vix dentato, externo spinoso, carinis lateralibus distinctis ante apicem conjunctis instructa, unicolora margine apicali tenuissime albido-ciliato. Femora coxae et dimidium basale tibiarum posticorum rufa; tibiae tarsique fusca; tarsi breves, articulus basalis posticorum 2° et 3° simul sumtis multo brevior. Long. corporis 8 mm.

BASILAN (*Baker*). Baker collection.

A single male. Resembling *Glenea maura* Pascoe, but at once distinguished by its much broader head, shorter prothorax, reddish femora, and the entirely white sides of the prothorax.

Glenea albolineata Thomson var. **mindanaonis** var. nov.

Violascente-nigra supra albovittata, infra dense albo-tomentosa maculis lateralibus denudatis nigris. Caput pronoto haud latius oculis haud vel vix tumidis. Frons latitudine altior, utrinque vitta albida; in medio punctata, nuda. Genae lobis inferioribus oculorum parum breviores nudae (♀) vel albo-pubescentes (♂). Tempora vitta obliqua albida. Vertex 4-vittatus; vittae intermediae tenues parallelae, laterales pone oculos breves latiusculae. Antennae ad basin modice distantes tuberculis distinctis, corpore longiores, nigrae. Scutellum macula media apicali albida. Elytra a basi usque ad medium punctata, pone medium fere laevia, apice subtruncata angulo externo spinoso, suturali dentato, carinis lateralibus postice obtusis subaequalibus, prope apicem conjunctis, vittis 7 rectis, bene separatis, linearibus, optime definitis ornata [vitta communi suturali, vitta discali medium (♀) vel apicem fere (♂) attingente, vitta humerali apice libera (♀) vel cum fascia apicali connexa (♂) vittaque infrahumerali inter carinas] margine apicali etiam albido. Pedes cinereo-pubescentes; tarsi breves, posticorum articulus basalis 2° et 3° simul sumtis brevior vel haud longior. Long. corporis 10–14 mm.

♂. Segmentum ultimum ventrale apice convexum vel obtuse carinatum.

MINDANAO, Surigao, Surigao: Agusan, Butuan. SAMAR (*Baker*). Riksmuseum, Stockholm; Baker collection.

Specimens from Bouru differ by having the white stripes of the prothorax much broader and the stripes of the elytra more or less united, at least at apex. In a male from Bouru the last ventral segment is very long, fornicate and distinctly carinate at apex.

Glenea flavotincta var. nov. vel sp. nov.

As a very doubtful form of *G. albolineata* I regard two females, one from Samar in Baker's collection and one from Mindanao in the Riksmuseum, Stockholm. They differ in having all the stripes of the upper side yellow, the discal and humeral stripes of the elytra much broader and posteriorly more or less dissolved in rounded or irregular spots. In the specimen from Samar the humeral stripe is continuous and the discal only at and behind

the middle represented by two or three dots, but in the specimen from Mindanao both stripes are, from the middle, replaced by very irregular yellow spots. The most important difference, however, is that the forehead is much broader and the cheeks are shorter than in *G. albolineata.*

Glenea curvilinea sp. nov.

♂. Nigra, supra griseo-vittata, infra omnino albido-tomentosa maculis nullis pedibus cinereo-pubescentibus. Caput cum oculis tumidiusculis pronoto vix latius. Frons latitudine parum altior. Genae mediocres, lobis inferioribus oculorum haud duplo breviores. Antennae ad basin distantes, corpore longiores nigrae. Caput totum albido-tomentosum vitta media verticis nigra. Prothorax subcylindricus, prope basin leviter constrictus, supra albido-trivittatus vittis externis latis. Scutellum albido-tomentosum. Elytra apice emarginato-truncata angulo externo spina ornato, costis lateralibus apice conjunctis parum distinctis, vittis ternis (prima lata ad basin discali, mox autem versus suturam curvata et eam usque ad apicem adjuncta, secunda humerali maculam apicalem attingente, tertia latera deflexa fere omnino occupante) maculaque apicale griseis ornata, ante medium punctata pone medium fere laevia. Segmentum ventrale ultimum infra planum. Long. corporis 10–11 mm.

MINDANAO, Agusan, Butuan (*Baker*). Riksmuseum in Stockholm and Baker collection.

Nearly allied to *G. albolineata* Thomson, but distinct by having the discal stripe of the elytra curved at the base and soon reaching the suture. I have not seen the female.

Glenea regularis Newman.

Glenea regularis NEWMAN, Entomologist 1 (1842) 302.

LUZON, Camarines Sur, Mount Isarog: "Manilla" (Thorey): Laguna, Mount Maquiling.

Glenea palauensis Aurivillius.

Glenea palauensis AURIVILLIUS, Arkiv f. Zool. 1 (1903) 325, fig. 29.

PALAWAN.

Glenea basalis Aurivillius.

Glenea basalis AURIVILLIUS, Arkiv f. Zool. 15 (1923) 39.

LUZON.

Glenea versuta Newman.

Glenea versuta NEWMAN, Entomologist 1 (1842) 302; Arkiv f. Zool. 15 (1923) 39, 40.

LUZON, Sorsogon, Aroroy. POLILLO.

Glenea versuta Newman ab. **bipunctata** Aurivillius.

Glenea versuta Newman, ab. *bipunctata* AURIVILLIUS, Arkiv f. Zool. 15 (1923) 39.

LUZON, Sorsogon, Aroroy. SAMAR.

Glenea versuta Newman ab. ♀ **fasciolata** Aurivillius.

Glenea versuta Newman ab. ♀ *fasciolata* AURIVILLIUS, Arkiv f. Zool. 15 (1923) 39.

MINDANAO. SIARGAO. BASILAN.

Glenea pulchella Pascoe.

Glenea pulchella PASCOE, Trans. Ent. Soc. London (2) 4 (1857) 260.
Glenea vesta PASCOE, Proc. Zool. Soc. London (1866) 260, t. 28, f. 3; Trans. Ent. Soc. London (3) 3 (1867) 411.

MINDANAO. MALACCA. BORNEO. MOLUCCAS.

Specimens from Mindanao have a small sulphur yellow lateral dot on the elytra behind the middle; this dot is wanting in specimens from Borneo and Malacca but still more developed in a specimen from Ceram.

Pascoe altered the name *pulchella* to *vesta* under the supposition that *G. pulchella* Hope was an older name; but Hope's species was not described before 1860, when it was introduced by Thomson as *G. pulchella*. Thomson's species may therefore be named *G. pulchra*.

Glenea bivittata Aurivillius.

Glenea bivittata AURIVILLIUS, Arkiv f. Zool. 1 (1904) 326, fig. 30.

PALAWAN.

Glenea cinerea Thomson.

Glenea cinerea THOMSON, Syst. Ceramb. (1865) 565.

LUZON. MINDORO.

A somewhat variable species. The four black spots of the elytra large and squarish or smaller and rounded.

Glenea colobotheoides Thomson.

Glenea colobotheoides THOMSON, Syst. Ceramb. (1865) 562.

LUZON. SIARGAO. MINDANAO. BASILAN.

The following three species are unknown to me:

Glenea glauca Newman.

Glenea glauca NEWMAN, Entomologist 1 (1842) 302.

LUZON, Manila.

Glenea stellata Thomson.

Glenea stellata THOMSON, Syst. Ceramb. (1865) 563.

"BORNEO?" MINDANAO?.

Glenea varifascia Thomson.

Glenea varifascia THOMSON, Syst. Ceramb. (1865) 562.

MINDANAO. ? = *regularis* Newm.

Glenea ana Thomson and *ochraceovittata* Thomson have been reported from the Philippine Islands, but were probably wrongly named.

Subgenus **Stiroglenea** Aurivillius

The majority of the species belonging to this subgenus have the same colors and markings as have the well-known *G. cantori* Fabricius from China and *G. angerona* Thomson from Java. Front broad and subquadrate. Hind tarsi short. Prothorax short, strongly constricted behind middle. Eyes moderately tumid. Humeral keel of the elytra ending free near apex; subhumeral keel distinct and acute at apex.

One species only is known from the Philippine Islands.

Glenea (Stiroglenea) luzonica sp. nov.

Nigra, albido pubescens; elytra (parte 5[a] apicali nigra excepta) femora et tibiae anteriora abdomeneque rufo-brunnea. Caput albido-tomentosum macula frontis et vitta media verticis nigris. Prothorax albido-tomentosus, supra facia transversa basali maculisque duabus subquadratis ante medium, utrinque in latere guttis 4 denudatis nigris. Scutellum nigrum. Elytra leviter griseo pubescentia macula apicali cano-tomentosa. Latera pectoris nigro-guttata. Segmenta ventralia 1–4 utrinque late denudata. A *G. angerona* Thomson, cui proxime affinis, parte nigra apicali elytrorum multo breviore et signatoris prothoracis diversa. Long. corporis 11 mm.

LUZON, Camarines Sur, Mount Isarog. Riksmuseum, Stockholm, 1 female.

Genus **HETEROGLENEA** Gahan

Head broad with tumid eyes. Hind tarsi short.

Heteroglenea glechoma Pascoe.

Heteroglenea glechoma PASCOE, Trans. Ent. Soc. London (3) 3 (1867) 409; GAHAN, Ann. Nat. Hist. (6) 19 (1897) 490.

Heteroglenea fuscovirgata FAIRMAIRE, Ann. Soc. Ent. Belg. 27 (1883) 53.

MINDANAO. May easily be mistaken for a *Daphisia.*

Genus **DAPHISIA** Pascoe

The species are as a rule smaller than the species of *Glenea* and easily known by the rounded sides of the elytra. Head

broad with tumid eyes. Hind tarsi generally short. Lateral keels of the elytra wanting or obsolete, never reaching the apex.

Key to the species of Daphisia Pascoe.

a^1. Elytra truncate or slightly rounded at apex, unarmed. First joint of hind tarsi at least as long as the two following together. Elytra with a broad sutural stripe, a short discal stripe at the base sometimes united to the sutural stripe, a discal spot near middle, a humeral stripe not reaching the base and usually thickened at its posterior end and an apical spot gray or yellowish gray. All the markings sometimes united and nearly concealed by a grayish or yellowish tomentum (ab. *confluens*). Femora pale reddish at least at base .... **D. discimaculata** Aurivillius.

a^2. Elytra truncate with the exterior angle dentate or spined. Elytra without stripes. Scutellum white.

b^1. Larger, 9 to 10 millimeters. Entirely pale brown with two large white spots on each side of the breast .... **D. brunnea** sp. nov.

b^2. Smaller, 6 to 8 millimeters. Black; prothorax with three white stripes, elytra as a rule with two spots near base and a transverse fascia behind the middle white .... **D. bakeri** sp. nov.

Daphisia discimaculata Aurivillius.

Daphisia discimaculata AURIVILLIUS, Arkiv f. Zool. 15 (1923) 41.
Daphisia discimaculata ab. ♀ *confluens* AURIVILLIUS, Arkiv f. Zool. 15 (1923) 41.

MINDANAO.

Daphisia brunnea sp. nov.

♀. Tota testaceo-brunnea, brunneo-pubescens, scutello maculisque utrinque 4 lateralibus pectoris et abdominis (prima in mesosterno, secunda in metasterno, tertia parva in segmento ventrali primo, quarta elongata in segmento ultimo) dense albotomentosis. Frons lata, subtransversa, punctata. Genae lobis inferioribus oculorum fere longiores. Antennae corpore parum longiores; scapus articulo 3° haud brevior. Pronotum subtransversum, basin versus levissime angustatus et ante basin obsolete constrictus, ante scutellum albo-tomentosum. Scutellum semiorbiculare. Elytra utrinque a basi ultra medium obtuse bicarinata carinis ante apicem evanescentibus, apicem versus parum angustata, apice truncata et extus spinosa, subseriatim punctata quarta parte apicali fere laevi. Tarsi breves. Unguiculi simplices. Long. corporis 9–10 mm.

SAMAR (*Baker*). Baker collection; Riksmuseum, Stockholm.

A very distinct species, forming a connecting link between *Glenea* and *Daphisia*.

Daphisia bakeri sp. nov.

Nigro-fusca, supra albo-vittata et -maculata, infra albido-pubescens vitta laterali pectoris et abdominis dense albo-tomentosa; pedes toti pallidi aut plus minus infuscati. Caput cum oculis pronoto latius. Frons subquadrata, punctulata, grisea; genae et tempora alba; vertex unicolor, fuscus. Oculi late distantes, mediocres; lobi inferiores genis duplo (♂) vel parum (♀) longiores. Antennae fuscae, corpore duple (♂) aut sesqui longiores; scapus articulo 3° parum brevior, interdum rufescens. Pronotum dense punctulatum, basin versus leviter angustatum lateribus rectis, albido-trivittatus vitta media tenui vel interrupta. Scutellum obtusum dense albo-tomentosum. Elytra linearia, apice truncata, leviter dentata vel fere inermia, fere ad apicem punctata, griseo-pubescentia (♂) vel subnuda (♀) guttis binis ante medium, macula transversa pone medium albis vel flavidis maculaque obsoleta grisea apicali ornata. Tarsi breves. Long. corporis 6–8 mm.

NEGROS. SAMAR. SIBUYAN (*Baker*). Baker collection; Riksmuseum, Stockholm.

The two antemedial spots of the elytra are obliquely placed, the interior elongate and somewhat nearer to the base than the exterior.

Daphisia bakeri var. **vittulata** var. nov.

♂. A forma typica differt vertice flavido-bivittato maculisque elytrorum flavescentibus. Femora testacea; tibiæ et tarsi infuscata.

BASILAN. Baker collection.

Daphisia bakeri var. **semisignata** var. nov.

A forma typica differt macula antemediana interiore elytrorum deficiente maculaque transversa postmediana majore. Pedes toti testaceo-brunnei.

MINDANAO, Surigao, Surigao. Baker collection.

Daphisia bakeri var. **immaculata** var. nov.

Elytris unicoloribus immaculatis omnino pube virescente-grisea tectis insignita.

NEGROS. MINDANAO, Lanao, Kolambugan. Baker collection.

SAPERDINI

Genus **PARAZOSNE** novum

Tibiae intermediae integrae. Antennae (♀) corpore breviores, articulis 4–11 opacis. Frons inter oculos constricta.

Tubercula antennifera divergentia sulco angulari separata. Oculi emarginati; lobi inferiores subquadrati. Prothorax cylindricus, ante basin levissime constrictus. Elytra lateraliter costato-deflexa, carinis prope apicem omnino evanescentibus, apice truncata fere inermia. Tibiae apicem versus sensim compresso-dilatatæ. Tarsi breves; articulus primus posticorum 2° et 3° simul sumtis haud longior.

I have been compelled to erect this new genus for the rare and beautiful insect described and figured by Westwood in 1841 as *Colobothea leucospilota* and hitherto referred to the genus *Glenea,* from which it however differs by having the middle tibiæ entire without incision.

The only specimen I have seen is a female and it was taken at Surigao, Mindanao, by Baker. The white markings of the elytra agree rather well with the spots in Westwood's figure.

Parazosne leucospilota Westwood.

Colobothea leucospilota WESTWOOD, Arc. Nat. 1 (1841) 57, pl. 15, fig. 2.

Chalybeate, more or less purple at the sides of the elytra, shining and spotted with white. Front on each side bordered with a fine white line, embracing the outer side of the antennary tubers. Cheeks whitish. Vertex without stripes. Prothorax nearly as long as broad with very few punctures, strongly shining, three small spots above near apical margin and a transverse spot at the base white. Scutellum white, black at base. Elytra very strongly punctured at base and at the sides, shining and without punctures in apical fifth; each with six or seven white markings; a discal dot near base, a short transverse fascia near middle, a lateral dot between the first dot and the fascia, a dot near the suture behind middle, a lateral dot behind the last, an oblique fascia before apex, and often also an apical spot. Body beneath with grayish pubescence along the middle and with white patches on the breast and white apical margins to the first four ventral segments. Femora bluish; tibiæ dark violet; tarsi black. Length, 19 millimeters.

LUZON. MINDANAO.

PHILIPPINE AND MALAYAN PLOIARIINÆ (HEMIPTERA, REDUVIIDÆ)

By W. L. McAtee and J. R. Malloch

Of the Bureau of Biological Survey, Washington, D. C.

FOUR PLATES

The collections reported upon herewith were submitted by C. F. Baker and H. M. Pendlebury. A few specimens from other sources also are included. That there is considerable variety among these insects in the regions concerned is indicated, not only by the diversity of the present collections, but also by the large number of previously described forms, as listed in the bibliography. We regret that we cannot identify a greater proportion of these old species, but the descriptions in most cases fail to mention characters we have found indispensable in classification. Were specimens of these previously established species available for study, however, we have no doubt that most of them would prove distinct from those in hand, as we find a wealth of characters available for segregation of species in the group. We are not so sure that many of the previously described genera would be retained; the natural groups of Ploiariinæ entitled to generic rank are relatively few, in our opinion, and apart from those included in this paper various segregates ranked as genera probably would be better placed as subgenera. The scheme of classification used follows that adopted by the writers for the American Ploiariinæ,[1] with modifications called for by the characters of the material examined.

In accordance with Professor Baker's liberal arrangements, the holotypes of species collected by him and odd-numbered specimens are retained by us, and even-numbered specimens are returned to him. The types from Mr. Pendlebury's material are being deposited in the British Museum, by request of the collector, and only a few duplicates are retained.

[1] Proc. U. S. Nat. Mus. 67 (April, 1925) 1–153, pls. 1–9.

Key to the genera of the Ploiariinæ.

1. Fore tarsus short, normal in form, similar in size and structure to the mid and hind pairs, the segmentation visible under moderate magnification, the claws small and equal; fore tibia four or five times as long as fore tarsus, usually over four-fifths as long as fore femur .... 2.

   Fore tarsus more or less elongate, longer than mid and hind pairs, and of different structure, heavily chitinized, segmentation visible only under high magnification, or in other cases obsolete, with an unequal pair of claws or a single claw; fore tibia never more than twice as long as, and sometimes shorter than, fore tarsus, usually less than half as long as fore femur .... 8.

2. Fore tibia at least four-fifths as long as fore femur, armature of femur beginning near base .... 3.

   Fore tibia only about half as long as fore femur, armature of femur beginning some distance from base .... **Gardena** Dohrn.

3. Basal sternite deeply angularly emarginate apically (Plate 3, fig. 29); forewing usually with only one closed cell (Plate 3, figs. 23, 30); prothorax only moderately constricted .... 4.

   Basal sternite not deeply angularly emarginate apically; forewing usually with two closed cells (Plate 1, figs. 1, 2; Plate 3, figs. 34, 35); prothorax usually deeply constricted .... 6.

4. Fore tarsi 3-segmented; head, anterior lobe of prothorax, and fore legs uniformly clothed with long hairs .... **Ademula g.** nov.

   Fore tarsi 2-segmented; head, anterior lobe of prothorax, and fore legs not uniformly clothed with long hairs .... 5.

5. Fore femur with tufts of bristles above; forewing with a small closed cell at base of discal cell (Plate 3, fig. 26) .... **Tridemula** Horvath.

   Lacking these characters .... **Empicoris** Wolff.

6. Mesonotum and metanotum without spines; fore tarsi 3-segmented. **Myiophanes** Reuter.

   Metanotum at least with a spine; fore tarsi 2-segmented .... 7.

7. Mesonotum and metanotum each with a spine; prothorax pedunculate. **Stenolemus** Signoret.

   Mesonotum without spine; metanotum and first tergite each usually with a spine; prothorax merely constricted .... **Emesopsis** Uhler.

8. Fore tarsus visibly segmented under high magnification; armature of fore femur extending along practically the whole length of the ventral surface .... 9.

   Fore tarsus unsegmented; armature of fore femur confined to apical half or less of ventral surface .... 10.

9. Pronotum extending over mesonotum to bases of wings; apparent posterior margin of prosternum as seen from below convex in outline. **Bagauda** Bergroth.

   Pronotum not extending over mesonotum except at its apex, falling much short of bases of wings; apparent posterior margin of prosternum as seen from below usually depressed medianly, appearing emarginate .... **Ploiaria** Scopoli.

10. Fore tarsus including claws shorter than fore tibia, the claws paired, unequal, short and curved; third antennal segment about one-tenth as long as fourth; head longer behind than in front of eyes .... 11.

Fore tarsus including claw longer than fore tibia, the claw single, nearly straight, and about one-third as long as tarsus (Plate 4, fig. 55); third antennal segment about half as long as fourth; head shorter behind than in front of eyes .... **Phryxobotrys** g. nov.

11. Metathorax much shorter than mesothorax .... **Ischnonyctes** Stål.
Metathorax little if any shorter than mesothorax .... **Ischnobaena** Stål.

Genus **EMESOPSIS** Uhler

The oriental fauna teaches us in this case, as in many others, that we must take a broad view of genera, or envisage the erection of an indefinite additional number of them. At first glance the reticulate-veined base of the forewing, as exemplified by the genotype of *Emesopsis,* would seem distinctive; but in the present collection there are species in which one can scarcely decide whether the reticulation really consists of veinlets or is merely color pattern. There are various styles of this reënforcement of the base of the wing, varying from broadened basal veins (as in *E. velutinervis,* Plate 1, fig. 9) to the narrow strip of minute reticulations of species like *E. neptunis* (Plate 1, fig. 1), and the definitely cross-veined condition of the genotype (*E. nubilus* Uhler). We see no grounds for generic distinctions in this material.

Calphurnia Distant,[2] although described as having the anterior tarsi 3-segmented, possibly is a synonym of *Emesopsis.* The same is true of *Calphurnioides* Distant.[3] *Bironiola* Horvath[4] also is not far removed.

Key to the subgenera and species of Emesopsis Uhler.

1. A small closed cell at inner anterior angle of discal cell of forewing (Plate 1, figs. 1 to 3); head and thorax copiously pubescent; armature of fore femur bristly, without spines .... 2.
No small closed cell at inner anterior angle of discal cell of forewing (Plate 1, fig. 4); head and thorax sparsely haired; mid and hind femora somewhat clavate at both extremities, a single prominent spine near base, and a few spinules scattered along ventral surface of fore femur (*Pseudobolos* subg. nov.; subgenotype, *velutinervis* sp. nov.) .... 8.
2. A stump of a vein emanating from apex of discal cell in addition to the vein that runs toward apex of wing, the latter vein with a branch toward costal margin which is bifurcate, the rami evanescing; forewing with ocellate spots, but lacking cross veinlets basad of small discal cell (Plate 1, fig. 1); dense pile of anterior lobe of pronotum interrupted by a glossy trident-shaped mark on each side (subg. *Hadrocranella* Horvath) .... 3.

[2] Ann. Mag. Nat. Hist. VIII 3 (1909) 502.
[3] Trans. Linn. Soc. London II 16 (1913) 164.
[4] Ann. Mus. Nat. Hung. 12 (1914) 639–640.

No stump of a vein at apex of discal cell; apical vein simple; forewing without ocellate spots; pronotum without trident-shaped bare areas; both costal and discal areas near base of wing with transverse veinlets or more or less veinlike dark markings (subg. *Emesopsis* Uhler) .... 4.

3. Small closed cell at base of discal cell distinct; wing basad of it with a very narrow strip of dark reticulations and without dark transverse lines (Plate 1, fig. 1) .... **E. (H.) neptunis sp. nov.**

   Small closed cell almost obsolete; wing basad of it with a broader stripe of dark reticulations and with a few dark transverse lines joining costa (Plate 1, fig. 2) .... **E. (H.) obsoletus sp. nov.**

4. Apical process of male hypopygium spinelike, the apices of claspers almost rectangularly upcurved (Plate 1, figs. 13, 14). **E. (E.) spicatus sp. nov.**

   Apical process of male hypopygium broad, more or less scooplike, that is, the posterior surface distinctly concave (Plate 1, fig. 15); claspers little if any upcurved .... 5.

5. Discal cell of forewing with a subquadrate dark spot notably larger than its fellows, at bend of the vein closing its apex on anterior half (Plate 1, fig. 6); ædeagus with the dorsal hooks broad and strong (Plate 2, figs. 19, 20) .... 6.

   Discal cell of forewing with the dark spots along veins closing its apex subequal in size (Plate 1, fig. 5); ædeagus with the dorsal hooks slender (Plate 2, figs. 21, 22) .... 7.

6. Hypopygium of male as in Plate 2, fig. 19 .... **E. (E.) gaius sp. nov.**

   Hypopygium of male as in Plate 2, fig. 20 .... **E. (E.) gallienus sp. nov.**

7. Hypopygium of male as in Plate 2, fig. 21 .... **E. (E.) nero sp. nov.**

   Hypopygium of male as in Plate 2, fig. 22 .... **E. (E.) hadrian sp. nov.**

8. Mid and hind femora slightly thickened at bases and apices, slenderer mesially, with three slight beadlike swellings, one before and one beyond middle, the other just before apex; hypopygium of male large, the apical spine thick, tapered to a sharp point; not much curved upward, and extending beyond apices of claspers (Plate 1, fig. 16) .... **E. (P.) moniliferus sp. nov.**

   Mid and hind femora lacking beadlike swellings; apical spine of male hypopygium more or less erect, shorter than claspers .... 9.

9. Posterior lobe of pronotum faintly rugose; longitudinal veins of basal part of forewing deep velvety black, not connected by transverse markings or veinlets (Plate 1, fig. 9) .... **E. (P.) velutinervis sp. nov.**

   Posterior lobe of pronotum rather coarsely rugose; longitudinal veins of basal part of forewing not so deep black, connected by a dark marking, or by a thickening of the membrane .... 10.

10. Only one connection between longitudinal veins of basal part of forewing (Plate 1, fig. 8) .... **E. (P.) emmesius sp. nov.**

    Two connecting marks or veinlets between longitudinal veins of basal part of forewing (Plate 1, fig. 7) .... **E. (P.) connexus sp. nov.**

Emesopsis (Hadrocranella) neptunis sp. nov.

Male and female.—Head and body testaceous, the head and pronotum covered with dense gray pile and bearing sparse long hairs also, the venter with short sericeous pubescence. An-

tennæ stramineous, first segment with a dark annulus near base, and traces of one subapically; appressed pubescent, rather long-haired basally on first segment. Fore coxæ and mid and hind femora and bases of tibiæ with copious long spreading hairs, most of which are about six times as long as diameter of parts on which they are situated; mid and hind femora with brownish traces of subapical annuli. Fore femur pale brownish, with median, subapical, and apical, whitish annuli (Plate 1, fig. 10); fore tibia chiefly pale, with a subbasal and an apical brownish annulus. Forewing whitish hyaline, the veins yellowish to brownish, that from the small closed cell toward base of wing paralleled on each side by a narrow strip of fine brownish reticulations; stigma with a dark dot near base; interior of large discal cell with irregular blackish irroration; a conspicuous round black spot just posterior to discal cell and a larger, irregularly quadrate spot on each margin of wing behind that; apex of wing with two or three dusky spots; veins in apical half of wing margined with dusky (Plate 1, fig. 1).

Basal segment of antenna and mid and hind femora slightly clavate apically. Mesonotum rather normally scutellumlike, metanotum and first tergite each with a prominent spinelike tubercle. Abdomen gradually widened from base to near apex; hypopygium and apex of last tergite of male as in Plate 2, fig. 17.

Length, 5 to 6 millimeters.

Holotype male, allotype, and 3 male paratypes, Surigao, Mindanao; paratype, Mount Maquiling, Luzon (*Baker*).

This species is allied to *Ploiariodes medusa* Kirkaldy[5] but apparently is distinct.

So far as we can judge from the description and figure, *Hadrocranella imbellis* Horvath[6] is so closely related to *medusa* and *neptunis* that its generic name may properly be used for the group we regard as a subgenus of *Emesopsis*.

Emesopsis (Hadrocranella) obsoletus sp. nov.

Male.—Hairs much less conspicuous than in *E. neptunis* except on fore coxæ. Antennæ stramineous, first segment with a broad subbasal, a narrow median, and a subapical narrow annulus, second segment with a broad subbasal and a narrow apical annulus, fuscous; third segment darkened near base and on the apical half, and fourth at base and apex. Mid and hind femora

[5] Proc. Linn. Soc. N. S. W. 33 (1908) 373, pl. 4, fig. 12 (Fiji).

[6] Ann. Mus. Nat. Hung. 12 (1914) 647–649, fig. 8 (New Guinea).

with three widely spaced dark annuli, and tibiæ with two near base; fore coxa broadly fuscous at apex, and with a narrow fuscous median annulation, in structure slenderer basally than in *E. neptunis;* fore femur with a broad subbasal, a broad subapical, and a narrow median annulus, fuscous, the subbasal annulus pale in center (Plate 1, fig. 11); fore tibia with a narrow and a broader fuscous annulation near base, and the apex fuscous. Forewing pattern much as in *E. neptunis,* with the differences described in key, and stigma with a conspicuous black spot apically; large quadrate spot beyond apex of discal cell on inner side of wing divided into two (Plate 1, fig. 2). Abdomen testaceous, rather conspicuously blackened on apical third except tip, much more strikingly attenuated basally and more abruptly widened from middle to near apex than in *neptunis;* hypopygial claspers and apical process shaped much as in *hadrian.* Scutellum not elongate triangular as in the other species of the subgenus, but broadly rounded in posterior outline and with a blunt convexity centrally.

Length, 5 millimeters.

SINGAPORE, holotype and paratype (*Baker*).

This species is even more closely similar than *E. neptunis* to *Ploiariodes medusa* Kirkaldy, but there are some points of difference (as *medusa* having two dark annuli close to base of each mid and hind femur), and geographic considerations lead us to believe that with the specimens in hand other distinctions could readily be found.

Emesopsis (Emesopsis) spicatus sp. nov.

Male.—General color of head and thorax fuscous, with grayish flocculose pubescence; antennæ and mid and hind legs testaceous, with spreading hairs basally and appressed pubescence apically. Antennæ with indistinct darker annulations; fore coxa with a single subapical fuscous annulus; fore femora much stouter than in the two preceding species (Plate 1, fig. 12), with five faint fuscous annuli; mid and hind legs without dark annulations, the tibiæ somewhat darker than femora, the latter slightly clavate, surface hairs not or but slightly longer than femoral diameter. Forewing with dark lines in both costal and radial areas basad of discal cell; remainder of wing with irregular dusky blotches. Hypopygium as in Plate 1, figs. 13, 14; Plate 2, fig. 18.

Length, 6 millimeters.

SIBUYAN, holotype (*Baker*).

Emesopsis (Emesopsis) gaius sp. nov.

Male and female.—The general color of head and body testaceous, of appendages stramineous, the former covered with close, crisped, gray pubescence, the latter with somewhat longer, straighter, and mostly appressed hairs. Subbasal annulus on first segment of antenna and extreme base of second segment fuscous. Fore legs structurally as in *E. spicatus,* with indistinct brownish annulations, a subapical one on coxa, three or four on femur and on tibia; mid and hind femora with three or four narrow dark annuli, the dark parts slightly thickened; tibiæ of these legs in general darker than the femora, sometimes with two or three faint dark annuli. Transverse dark lines on basal third of forewing distinct, a large dusky blotch on each margin opposite small discal cell, remainder of wing with numerous irregular dusky spots (Plate 1, figs. 3, 6). Male hypopygium as in Plate 2, fig. 19.

Length, 6 millimeters.

SINGAPORE, holotype, male allotype, 1 male and 4 male paratypes (*Baker*).

Emesopsis (Emesopsis) gallienus sp. nov.

Male.—Coloration much as in *E. gaius;* fore femur and tibia each with four fuscous annulations. Wing markings less distinct. Hypopygium as in Plate 2, fig. 20.

Length, 6 millimeters.

PALAWAN, Puerto Princesa, holotype and paratype (*Baker*).

Emesopsis (Emesopsis) nero sp. nov.

Male and female.—Ground color of body testaceous, of appendages stramineous; gray vestiture of former rather woolly, of latter mostly appressed. Basal segment of antenna with several narrow brownish annuli, much more conspicuous on under than on upper side. Fore coxa with a subapical brown annulus, more conspicuous on inner side; fore femur with about four faintly indicated annuli on outer side, and a continuous brown longitudinal stripe on the inner; fore tibia brownish at base and apex. Mid and hind femora each with four faint brownish annulations. Forewings whitish hyaline, markings pale brownish; veins costad of small discal cell, and a small spot at apex of stigma darker; spots in discal cell as in Plate 1, fig. 5. Male hypopygium as in Plate 1, fig. 15; Plate 2, fig. 21.

Length, 6 millimeters.

Holotype, male, allotype, 1 male and 3 female paratypes, Mount Maquiling, Luzon; 2 male and 2 female paratypes, Basilan (*Baker*).

Emesopsis (Emesopsis) hadrian sp. nov.

Male.—Coloration as in *E. nero,* but the dark markings, especially of the appendages, fainter. Male hypopygium as in Plate 2, fig. 22.

Length, 6 millimeters.

LUZON, Mount Maquiling, holotype (*Baker*).

Emesopsis (Pseudobolos) moniliferus sp. nov.

Male.—General color testaceous, eyes, posterior lobe of pronotum, bases of forewings, and underside of mesothorax blackish. Pubescence of pronotum longer than on other parts of the insect, but scarcely woolly; that of abdomen and appendages mostly appressed. Basal segment of antenna with the faintest indications of brownish annuli, the "beads" of mid and hind femora washed with brownish. Forewings hyaline, veins near base of the long stigma blackish.

Metanotum with a long, slender, slightly recurved, acute, and pale spine; mesonotum and first tergite rounded tuberculate. Hypopygium as in Plate 1, fig. 16.

Length, 7 millimeters.

MINDANAO, Zamboanga, Dapitan, holotype (*Baker*).

Emesopsis (Pseudobolos) velutinervis sp. nov.

Male and female.—General color testaceous, eyes and posterior lobe of pronotum blackish. Antennæ and legs without dark annulations; segments 2 to 4 of antennæ sometimes blackish. Forewings whitish hyaline, two longitudinal vittæ over veins in basal half of wing and one or two in discal cell velvety black (Plate 1, fig. 9); narrow markings paralleling other veins and margins, two curved streaks in subapical part of wing, and a series of wedge-shaped blotches about apex, dusky.

Length, 4.5 to 5 millimeters.

Holotype, male, and allotype, Mount Maquiling, Luzon; 1 male and 1 female paratypes, Dapitan, Mindanao (*Baker*).

Emesopsis (Pseudobolos) connexus sp. nov.

Male and female.—Coloration almost exactly as in *E. velutinervis* (except for that of the forewing which differs as stated in key and shown in Plate 1, fig. 7) and in having irregular

blotches instead of regularly arranged wedge-shaped spots at apex. The posterior lobe of pronotum also tends to be less extensively blackened.

Length, 5 to 6 millimeters.

BORNEO, Sandakan, holotype, male, allotype, 1 male and 1 female paratypes (*Baker*).

Emesopsis (Pseudobolos) emmesius sp. nov.

Female.—General coloration as in *E. connexus;* forewing differing as stated in key, and illustrated in Plate 1, figs. 4 and 8, fore legs somewhat darker, the femur with a more or less distinct median pale annulus.

Length, 6 millimeters.

Holotype, Sibuyan; paratype, Basilan (*Baker*).

Genus **ADEMULA** novum

Closely similar to *Empicoris,* differing essentially in having the fore tarsi 3-segmented. In both species of the genus before us the stigma of forewing is carried much nearer to apex of wing than is the case in any species of *Empicoris* or *Tridemula* we have seen, and the lateral pronotal carina is incomplete, which is only exceptionally the case in *Empicoris.* Mesonotum and first tergite each with a spine; metanotum only tuberculate.

Genotype, *Ademula reticulata* sp. nov.

Key to the species of Ademula g. nov.

1. Dark markings of forewing with fine reticulating white lines intersecting them (Plate 3, fig. 23); hind lobe of pronotum little if any darker than front lobe; fore femora very densely haired. **A. reticulata** sp. nov.

   Dark markings of forewings not intersected by reticulating lines; hind lobe of pronotum dark fuscous, anterior lobe testaceous; fore femora less densely haired .... **A. nubecula** sp. nov.

Ademula reticulata sp. nov.

Male and female.—General color stramineous, head, basal segment of antenna, anterior lobe of pronotum, and front legs with copious long hairs. Basal segment of antenna with two narrow dusky annulations near apex. Posterior lobe of pronotum with three more or less evident brown vittæ, anterior lobe of prothorax and posterior lobe of head in some cases darker medially. Forewing stramineous, with a practically continuous dusky vitta from near base to apex, this vitta with pale reticulating lines and spots; stigma with a faint brown spot at middle (Plate 3,

fig. 23). Hind wings unspotted. Mid and hind legs with a few very narrow annulations varying from faint brown to black, those near femorotibial joints the most noticeable. Fore femur with four, fore tibia with three, brown annuli, the hairs on which are darker than those of the adjacent pale areas. Venter sericeous with fine pale down.

The armature of the fore femur consists of a series of from three to five stout spines on the posteroventral surface, which are about half as long as the femoral diameter and extend from near base to beyond middle, and a series of short pale peglike spines on almost the entire length of ventral surface, with one or two longer ones situated at basal extremity of the series on the anteroventral surface, evidently to act as a rest for the opposing tarsus. Basal segment of antennæ and mid and hind femora slightly clavate. Hypopygium of male with a stout apical process which projects upward between the claspers and always separates them, the tip of the process more or less tumid (Plate 3, fig. 24).

Length, 5.5 to 6.5 millimeters.

Holotype, male, allotype, 1 male and 2 female paratypes, Singapore; paratypes, Sandakan, Borneo (*Baker*).

Specimens from the Philippines generally paler and with the wing markings especially reduced may be known as var. *abluta* var. nov. Holotype, female, Mount Limay, Luzon; paratypes Mount Limay, Mount Maquiling, Luzon; Dapitan, Mindanao (*Baker*); Kuala Lumpur, F. M. S., October 24, 1923, at light (*H. M. Pendlebury*).

Ademula nubecula sp. nov.

Male.—General color pale fuscous, hind lobe of head and front lobe of pronotum testaceous; antennæ, beak, and fore legs testaceous, the femora with four, the tibiæ with three, indistinct fuscous annuli; mid and hind legs stramineous, with touches of fuscous, especially near femorotibial joints. Pubescence much as in *A. reticulata*. Forewings whitish hyaline, with a nearly percurrent vitta, which is dusky bluish, without intersecting pale reticulating lines; the veins in the vitta are darker than those outside; pale areas modifying the shape of the vitta are at the base of the discal cell and at about the middle of the cell, another opposite latter on inner margin of the wing and at the wing apex, most of which is pale.

Mid and hind femora slightly, basal segment of antenna scarcely, clavate apically. Fourth antennal segment one-third as long as third. Armature of fore femur as in *A. reticulata*. Hypopygium with a much slenderer, erect, apical process hidden by the apices of claspers which meet on median line (Plate 3, fig. 25).

Length, 5.5 millimeters.

BORNEO, Sandakan, holotype (*Baker*).

Genus **TRIDEMULA** Horvath

The presence of a closed cell basad of the discal cell in forewing (Plate 3, fig. 26) and of four tufts of bristles on dorsal surface of fore femur, readily distinguishes this genus from *Empicoris*, to which it is most closely related. Both genera have the posterior lobe of pronotum more or less carinate laterally, and both have the basal abdominal sternite angularly emarginate apically, though in *Empicoris* the emargination is much less pronounced. There is a striking difference between the hypopygia of the two species of *Tridemula* here described (Plate 3, figs. 27, 28), but the same variation is found in *Empicoris*, most of the species with the apex deeply emarginate occurring in the Orient. Mesonotum and metanotum each with a spine, first tergite no more than tuberculate.

Genotype, *Tridemula pilosa* Horvath.

Key to the species of Tridemula Horvath.

1. Hind lobe of pronotum with a pale elliptical tubercle on middle of hind margin; stigma of forewing with a red line along its inner margin apically .... **T. plurima sp. nov.**
   Hind lobe of pronotum without a tubercle above; stigma without a red line .... **T. pallida sp. nov.**

Tridemula plurima sp. nov.

Male and female.—General color testaceous, basal two segments of beak and eyes blackish. Head with very short pale sericeous pubescence, first segment of antenna with sparse, long, spreading hairs, and remaining segments with shorter, more appressed hairs. Thorax with copious, short silvery pubescence and sparse long hairs, the pronotal tubercle somewhat paler than the surrounding surface. Forewing whitish hyaline, dusky maculate, spots at base and apex of stigma blackish; venation as in Plate 3, fig. 26. Hind wings unspotted. Mid

and hind legs whitish, a faint brownish band near apex of each femur. Fore coxa and femur with copious hairs of moderate length, and the femur with four, about equidistant, transverse tufts of blackish bristly hairs on its dorsal surface, 2 and 3 less conspicuous than 1 and 4, a broad annulus from tuft 1 to 3 and base and apex of femur pale; front tibia with two pale annuli near base. Venter with very short, pale, sericeous pubescence.

Pronotal tubercle elongate, elliptical as seen from above. None of the segments of legs and antennæ clavate. Venter of thorax and basal sternite as in Plate 3, fig. 29; penultimate sternite with a small rounded central apical lobe; ultimate sternite with a shallow rounded central apical emargination; apex of hypopygium bispinose (Plate 3, fig. 27). The armature of the fore femur consists of two series of short stubby spines, one anteroventral, the other posteroventral, with longer spines as in *Ademula* species.

Length, 6 millimeters.

Holotype, male, and allotype, Singapore; paratypes, male, Mount Maquiling, Luzon; female, Puerto Princesa, Palawan (*Baker*).

Tridemula pallida sp. nov.

Male.—Similar to *T. plurima* in vestiture and coloration, but paler. General color stramineous, eyes black, a dark vitta on head behind eye, stigmal spots less conspicuous than in *T. plurima*. Mid and hind legs with very faintly indicated dusky annuli, fore legs colored as in *T. plurima*.

Fore femur as well as the abdomen as in *T. plurima* except for hypopygium (Plate 3, fig. 28).

Length, 6 millimeters.

SINGAPORE, holotype (*Baker*).

Genus **EMPICORIS** Wolff

Mesonotum, metanotum, and first tergite each usually with a spine.

Key to the species of Empicoris Wolff.

1. Hind lobe of pronotum with a tubercle on middle of hind margin........ 2.
   Hind lobe of pronotum without a tubercle as above........ 3.
2. Pronotal tubercle small and inconspicuous, most easily seen from posterior view; posterior pronotal lobe brown, with lateral carinæ, hind margin, and two discal lines silvery white........ **E. bilineatus** sp. nov.
   Pronotal tubercle large and conspicuous; pronotal lobe with the pale discal lines very faint, or lacking........ 3.

3. Lateral carina of pronotum decidedly angulate about one-third from anterior end; length of forewing 3.5 millimeters; margin of hypopygium produced centrally, tip of process slightly emarginate (Plate 3, fig. 31 .... **E. bakeri sp. nov.**

Lateral carina of pronotum merely curved; length of forewing 5 millimeters; margin of hypopygium broadly excavated (Plate 3, fig. 32). **E. discalis sp. nov.**

4. Lateral carina of hind lobe of pronotum distinct only at anterior and posterior extremities and white only at former; apical black band on mid and hind femora falling distinctly short of apices of femora.... 5.

Lateral carinæ entire and all white, apical black band on mid and hind femora broad, extending to, or almost to, apices of femora.......... 6.

5. A bright red streak at inner apex of stigma. **E. rubromaculatus (Blackburn).**

Stigma not partly red. **E. rubromaculatus var. obsoletus McAtee and Malloch.**

6. Pigmentation more pronounced, discal cell of forewing densely maculate. **E. tessellatus sp. nov.**

Pigmentation less pronounced, discal cell of forewing chiefly hyaline. **E. lavatus sp. nov.**

Empicoris bilineatus sp. nov.

Described from a specimen with head and most of abdomen missing. Pronotum as described in key; forewings with numerous dusky blotches, leaving between them a whitish reticulation, three larger, more pronounced blotches on outer margin near apex, and a series of regularly spaced ones on inner margin, which decrease gradually in size from apex toward clavus, stigma with one basal and two apical black spots, venation about discal cell as in Plate 3, fig. 30; hind wings unspotted. Legs whitish, with narrow black annulations, the front leg with five on femur and four on tibia.

Carina on side of pronotum continuous, with a very short peglike process anteriorly; mesonotum and metanotum each with a short, slender, nearly erect spine; first abdominal tergite with a much longer, posteriorly curved, and slightly clavate process; mid and hind femora slightly clavate apically.

Length of forewing, 3 millimeters.

LUZON, Laguna, Mount Maquiling, holotype (*Baker*).

Empicoris bakeri sp. nov.

Male.—Head blackish brown, with silvery hairs, a definite band of which margins orbit; antenna moderately hairy, whitish, with numerous dark annulations. Pronotum brown, with the lateral carinæ and other lines of hairs silvery white, the median pair on posterior lobe not so well defined as in *E. bilineatus.*

Forewing marked much as in that species, with several large clear areas, however, and the spots at posterior end of stigma confluent; hind wing unspotted. Legs whitish, the posterior two pairs ornamented with alternating narrower and wider annulations; the fore legs with the dark markings more massed near ends of the segments.

Eye large, notably wider than interocular space; antenna half again as long as body, first segment slightly clavate apically. Lateral carina of pronotum clear-cut, distinctly elevated, its anterior extremity, however, scarcely produced; median tubercle of posterior lobe prominent; mesonotal and metanotal spines fully twice as long as in *E. bilineatus*, slender, directed upward and backward. Spine on first tergite like that of *E. bilineatus;* hypopygium from behind as in Plate 3, fig. 31. Mid and hind femora longer than body, scarcely clavate.

Length, 5 millimeters.

LUZON, Laguna, Mount Maquiling, holotype (*Baker*).

Empicoris discalis sp. nov.

Male.—A larger, more contrastingly marked species than *E. bakeri*, the ground color brownish black. Head with short pale hairs scarcely aggregated in lines. Antennæ and mid and hind legs appressed pubescent, with alternating dark annulations and spots. Fore leg with basal two-thirds of coxa, apex and two subapical bands on femur, and four annulations on tibia, the distal one widest, whitish. Pronotum with margin of posterior lobe, carinæ, and lines of hairs on anterior lobe silvery white; a large quadrate white spot on anterior disk of posterior lobe, prolonged anteriorly into the groove of anterior lobe. Markings of forewing much as in *E. bakeri*—that is, more conspicuous about the margins than discally, except near base; there is a large black spot on costa near base of discal cell, a small one at base, and a large one toward apex of stigma; hind wings unspotted.

Basal segment of antenna, and mid and hind femora scarcely clavate. Hypopygium from behind as in Plate 3, fig. 32.

Length, 6 millimeters.

Holotype, Jor Camp, Perak, F. M. S., March 10, 1924, at light (*Pendlebury*).

Empicoris lavatus sp. nov.

Male.—General color of head and body castaneous, head with pale hairs, which are more or less aggregated along orbits, be-

hind transverse impression, and about bases of antennæ; antenna whitish with dark bands, the bands on first segment narrower than, those on other segments about equal to, intervals, first segment with long spreading hairs, others with short, more appressed hairs. Disk of pronotum pale, anterior lobe, sides, and lateral carina of posterior lobe with lines of silvery hairs. Forewings sordid whitish, with mostly faint brownish blotches, the discal cell largely unmarked; stigma with one basal and two subapical brown spots; a larger solid brown spot on costa just beyond stigma. Hind wings unspotted. Venter with short silvery hairs. Legs whitish, with narrow, well-separated dark annulations, mid and hind femora with broader and darker terminal bands; fore femur dark, with two narrow pale annuli near middle.

Antennæ and mid and hind legs much longer than body, none of their segments clavate. Lateral carina of pronotum sharp and distinct throughout without process anteriorly, disk of posterior lobe with two low longitudinal swellings; hind margin trisinuate, without tubercle. Mesonotal and metanotal spines moderately developed, first tergite with a slender spine.

Length, 5 millimeters.

Holotype, Mount Maquiling, Luzon; paratype, Surigao, Mindanao (*Baker*).

Empicoris tessellatus sp. nov.

Female.—Agrees in most respects with *E. lavatus*, but decidedly more pigmented, especially the forewings. Basal segment of antenna without long, spreading hairs. Forewing densely maculate throughout, two spots in middle of discal cell notably larger than the others; stigma nearly covered by confluent dark spots basally, pale apically. Hind wings unspotted. Fore femur and tibia nearly black, the former with two, the latter with three, narrow pale bands.

Mesonotal and metanotal spines as in *E. lavatus*, the first tergite also with a slender spine which is slightly curved posteriorly.

Length, 5 millimeters.

SINGAPORE, holotype (*Baker*).

Empicoris rubromaculatus (Blackburn).

Ploiariodes rubromaculatus BLACKBURN, Proc. Linn. Soc. N. S. W. II 3 (1889) 349 (Hawaii).

A specimen from Mount Maquiling, Luzon (*Baker*), although somewhat heavily pigmented and having the median spines rather feebly developed, seems referable to this cosmopolitan species. A female specimen from the same locality, and a male from Dapitan, Mindanao (*Baker*), may be grouped with that from Funchal, Madeira (holotype), mentioned in our paper on the American Ploiariinæ (1925, p. 17) as *Empicoris rubromaculatus* var. *obsoletus* var. nov., characterized by the absence of a red streak in the stigma.

Genus **STENOLEMUS** Signoret

Key to the species of Stenolemus Signoret.

1. Hind femur with four narrow black bands, the basal two with dense brushlike tufts of black hairs (Plate 3, fig. 33); mid tibia with a small black spot close to base above and a black ring a little beyond it, the latter with long dense brushlike hairs; hind tibia without the subbasal black spot, the band broader and with longer hairs than midtibial band, and with a much narrower band with shorter hairs between it and middle of tibia .... **S. plumosus** Stål.

   Hind femur with four brown bands which are broader than the intervening white spaces, none of them with more conspicuous hairs than remainder of femur; mid and hind tibiæ brown, with three broad white bands, one at base and the apical one not much beyond middle, none of the dark bands conspicuously haired............ **S. quadriannulatus** sp. nov.

Stenolemus plumosus Stål.

Stenolemus plumosus STÅL, Öfv. Kgl. Vet.-Akad. Förh. 27 (1870) 702 (Philippines).

Female.—Head brownish fuscous, with gray downy hairs, which extend over basal segment of beak; antenna white, the basal segment with long, the others with numerous shorter pale hairs, basal segment with five fuscous annuli; second with four, which become progressively wider from base to apex, third yellow only at apex, fourth mostly dark, pale just before apex; each segment of beak broadly brown at base. Pronotum with a central pale line and two oblique, posteriorly convergent, pale lines on each side of anterior lobe, the lateral lines merging into one which extends along dorsum of petiole, posterior lobe largely brown, paler on each anterior lateral angle and with three faint paler dorsal vittæ; mesonotal and metanotal thorns dark brown, the latter pale at tip. All parts of thorax with sparse long spreading hairs, and copious surface down, pale. Abdominal venter brownish fuscous, with indications of three slender pale vittæ, and paler lateral margins to segments, the

elevated spiracles and lateral angles of segments darker; dorsum mostly dark brown. Legs white; fore legs with the following brown annuli: Coxæ, 2; femora, 4; tibiæ, 5; tarsi, 1. Mid legs annulate as follows: Femora, 4, all narrow, and a spot at apex above; tibiæ, 2, and a basal spot, the basal annulus furnished with dense black hairs forming a brush which is much deeper than diameter of tibia; apices of tibiæ, and the tarsi fuscous; hind legs annulate like the mid pair, but the two basal annuli on femora densely black-haired while only one is haired on mid legs and that only slightly, and the tibiæ have an additional black-haired annulus nearer middle, while the tuft of hairs on basal annulus is even more conspicuous than on mid pair (Plate 3, fig. 33); tip of tibia and the tarsus fuscous. Forewings chocolate brown, veins paler, some sections and a few short costal streaks as well as some reticulating marks near apex white, the discal cells with faint pale reticulations; hind wings fuscous.

Head across eyes wider than anterior lobe of pronotum; posterior lobe of head with two prominent sharp dorsal tubercles; beak stout; third segment of antenna one-third as long as fourth. Fore legs normal, the basal ventral spine sloped backward. Anterior lobe of prothorax with a rounded, polished tubercle on each side, petiole about 1.5 times as long as posterior lobe, the latter with four prominent sharp tubercles near hind margin; metanotal spine erect, about twice as thick as the horizontal mesonotal one, moderately hairy, almost straight, bluntly rounded at apex. Venter of abdominal segments 3 to 5 with the spiracles tuberculate, the segments angulate on the sides posteriorly. A short oblique vein emitted from near base of basal discal cell connects with costa, transverse vein to claval vein at middle of basal discal cell, posterior discal cell about 1.5 times as long as basal one; hind margin of apex of forewing slightly emarginate.

Length, 14 millimeters.

MINDANAO, Surigao, Surigao (*Baker*).

Stenolemus quadriannulatus sp. nov.

Male.—Paler than the preceding species, the dorsum of head with two pale vittæ uniting behind; petiole of pronotum pale, brownish on sides, posterior lobe yellowish white, with or without faint brownish vittæ, head and pronotum with longer sparse hairs and shorter dense pale reddish pubescence; veins of fore-

wings more conspicuously white than in *S. plumosus*, and the legs differing as stated in key; antennæ and legs moderately hairy, the latter without tufts.

Posterior lobe of head slightly depressed in middle anteriorly. Anterior lobe of pronotum with prominent "shoulders," each with a small domelike polished area; posterior lobe of pronotum with the four tubercles smaller and blunter than in the last species, the mesonotal and metanotal thorns slenderer, subparallel, projecting upward and backward, and slightly recurved. Venation of forewing similar to that of last species, but the posterior discal cell is more acutely pointed at apex, and the transverse vein connecting with anal vein is not over one-fourth from apex of basal discal cell. Venter colored as in preceding species, spiracles 3 to 5 less prominently tuberculate, and sides of segments scarcely angulate.

Length, 12 to 13 millimeters.

MINDANAO, Surigao, Surigao, holotype and paratype (*Baker*).

Stenolemus crassirostris Stål,[7] described from the Philippines, is smaller than either of the preceding species, has the peduncle of pronotum shorter than anterior lobe, and the beak distinctly thickened.

Genus MYIOPHANES Reuter

The species here described differ from previously described *Myiophanes* in having the forewings heavily pigmented, obliquely truncate, and somewhat emarginate on the inner half of apex, as in various species of *Stenolemus*. They agree with *Stenolemus* also in having two large closed discal cells in the forewing, and in having the mid and hind legs long, slender, long-haired, and annulate, and the fore femora spined beneath for their entire length. However, as in other species of *Myiophanes*, the anterior lobe of the pronotum is contracted and narrower than the posterior lobe, but not pedunculate as in *Stenolemus*. The fore femur has two series of spines and the fore tibia one series on ventral surface, about every fourth spine longer than the others, the basal posteroventral spine on femur not bent basad, and the anteroventral series not extending to base and without isolated basal spine. The 3-segmented tarsi of the fore legs and the absence of mesonotal and metanotal spines also distinguish the genus from *Stenolemus*.

Genotype, *M. tipulina* Reuter.

[7] Öfv. Kgl. Vet.-Akad. Förh. 27 (1870) 702, 703.

Key to the species of Myiophanes Reuter.

1. Mid and hind femora stramineous, each with three broad dark brown bands which together occupy about half of the surface; the tibiæ pale, each with a narrow subbasal brown annulus; forewing as in Plate 3, fig. 35 .... **M. annulifera sp. nov.**
   Mid and hind legs stramineous, the femorotibial region broadly whitish, bounded on each side by a narrow brown annulus; forewing as in Plate 3, fig. 34 .... **M. fluitaria sp. nov.**

Myiophanes annulifera sp. nov.

Female.—General color stramineous, the basal segment of antenna, the fore coxæ and femora, the hind legs, and the abdomen with moderately long spreading pale hairs. First segment of antenna brownish near base and apex; fore femora with three brownish annuli coalescent in a stripe on upper surface, also brownish apically; fore tibia with a subbasal annulus, and the apex brown; mid and hind legs as described in key. Pronotum with two broad lateral vittæ, and a long triangular mark with its base on the posterior margin, attenuate anteriorly, reaching nearly to middle of anterior lobe. Markings of forewing as in Plate 3, fig. 35.

Dorsum of head with a pronounced rounded elevation on middle of anterior margin of section behind the transverse depression, which projects slightly over the depression.

Length, about 15 millimeters.

Holotype, a dismembered specimen from Jor Camp, about 540 meters, Balang Padang, F. M. S., June 3, 1923 (*Pendlebury*).

Myiophanes fluitaria sp. nov.

Male.—General color stramineous, hairiness much as in *M. annulifera,* that on antennæ less conspicuous, that on legs more so; pronotum also long-haired. Antennæ scarcely annulate, the distal segments darker than the basal. Fore coxa with two, and fore femur with three, broad brownish annuli; fore tibia brownish except at base. Mid and hind legs as described in key. Pronotum colored much as in *M. annulifera,* the median vitta prolonged over anterior lobe, where it is expanded and interrupted by three narrow pale streaks. Coloration of forewing as in Plate 3, fig. 34.

No pronounced elevation behind transverse depression on dorsum of head. Apex of hypopygium with a long spike which is directed backward and curves upward, the claspers long, curved, slightly broadened near apices.

Length, 23 millimeters; of hind femur, 25; of hind tibia, 40.

Holotype, Kuala Lumpur, F. M. S., Gombak Valley, at light, October 13, 1921 (*Pendlebury*).

Genus GARDENA Dohrn

Key to the species of Gardena Dohrn.

1. Basal and apical unspined sections (that is, without long spines) of fore femora about equal in length, each a little less than half as long as the spined median section; head more than half as long as anterior lobe of prothorax .... **G. brevicollis** Stål.
   Basal unspined portion of fore femora almost or fully twice as long as the apical unspined portion, and but little or not at all shorter than the median spined portion; head distinctly less than half as long as anterior lobe of prothorax .... 2.
2. Fore femur without pale preapical annulus.
   G. melinarthrum var. **melinarthrum** Dohrn.
   Fore femur with conspicuous pale yellow preapical annulus.
   G. melinarthrum var. **femoralis** var. nov.

Gardena melinarthrum Dohrn.

Gardena melinathrum DOHRN, Emesina, Linn. Ent. 14 (1860) 214, 215 (Ceylon).

Gardena semperi DOHRN, Nachträge, Linn. Ent. 15 (1863) 64, 65 (Luzon).

Apparently *Gardena semperi* is the male of *G. melinarthrum*, as the only considerable character cited by Dohrn, "segments 1 and 2 of antenna strongly haired," is of sexual import only. The description of this species clears up a doubtful point in the original characterization; namely, as to relative lengths of the parts of the thorax. Here it is said that the "prothorax, not reckoning the part overlying the mesothorax," is as long as the mesothorax and metathorax together. The original description lacked the saving clause and was correspondingly misleading. Stål records *G. semperi* from the Philippines.[8]

With specimens in hand *Gardena bicolor* Distant[9] might prove separable from *G. melinarthrum*, but from the description it is not. Of the characters advanced, the length of the first antennal joint relative to the abdomen is sexual, and the degree of development of the wings is individual.

The genitalia of the oriental species of *Gardena* have not been described, so we append the following notes:

[8] Öfv. Vet.-Akad. Förh. 27 (1870) 704.

[9] Fauna British India, Rhynchota 2 (1904) 214, 215 (Burma).

Male.—Sixth sternite slightly and seventh very slightly emarginate, both medially and laterally; eighth sternite cuplike, opening upward, its hind margin with a median, erect, sharp spine; claspers slender, a little incurved, upturned and thickened apically; seventh tergite with a long, slightly spatulate, transversely corrugated flap, which extends nearly to apex of hypopygium (Plate 4, fig. 37).

Female.—Hind margin of seventh tergite nearly straight across; eighth tergite semielliptical, evenly convex posteriorly, ninth one and a half times as long as eighth, bluntly rounded apically, with a slight subapical, transverse elevation. Seventh sternite slightly concave laterally, and convex medially.

The genitalia in both sexes strongly resemble those of species of *Emesaya,* a different type from those of American species of *Gardena.*

Data for the specimens of *G. melinarthrum* examined in connection with the present paper are: Surigao, Iligan, Dapitan, Butuan, Mindanao; Mount Maquiling, Los Baños, Luzon (*Baker*). Samar, June 9, 1924 (*R. C. McGregor*). Kuala Lumpur, F. M. S., November 21, 1914; April 6, 1923 (*Pendlebury*).

The new variety *femoralis* is characterized by rather more copious, pale golden, sericeous pubescence throughout, and by the distinct, pale yellow, preapical annulus on fore femur. It does not differ appreciably in genital or other structural characters. Length, 25 millimeters.

Holotype, male, Kuala Tahan, Pahang, F. M. S., November 25, 1921 (*Pendlebury*).

Gardena brevicollis Stål.

Gardena brevicollis STÅL, Hemiptera insularum Philippinarum, Öfv. Kgl. Vet.-Akad. Förh. 27 (1870) 701.

In general color the single specimen of this species we have examined is paler than typical examples of *G. melinarthrum;* the mid and hind legs are testaceous, with dark annuli on each side of the pale femorotibial joints. The small size, relatively shorter head and pronotum, and the armature of fore femur as described in the key are characteristic.

Length, 14 millimeters.

Kuala Lumpur, F. M. S., Gombak Valley, at light, October 13, 1921 (*Pendlebury*).

Genus BAGAUDA Bergroth

Most nearly related to *Ploiaria,* having the same type of wing and venation (Plate 4, figs. 38, 39). The fore legs are very similar to those of the subgenus *Luteva,* but the basal segment of tarsus occupies a greater proportion of the total length in *Bagauda,* there is no isolated anterior bristle near the base as in *Luteva,* and there is a distinct series of minute bristles between the antero- and posteroventral series in both species we have before us. For other characters see key.

Key to the species of Bagauda Bergroth.

1. Seventh sternite of female nearly transverse apically; anterior lobe of pronotum with an impressed median line ending in a well-defined pit just in front of constriction; vein emanating from apex of discal cell about as long as the cell, the transverse vein joining it well beyond its middle (Plate 4, fig. 38); all femora brownish. **B. brunneus** sp. nov.

   Seventh sternite of female distinctly produced in an apically rounded triangular flap; anterior lobe of pronotum with the median line scarcely impressed; vein emanating from apex of discal cell not over half as long as the cell, the transverse vein joining it before its middle (Plate 4, fig. 39); fore femur with a broad preapical pale annulus and mid and hind legs with the femorotibial joints whitish. **B. lucifugus** sp. nov.

Bagauda lucifugus sp. nov.

Male and female.—Resembles *B. avidus* Bergroth in some respects, but is somewhat larger, has the wings shorter than the abdomen, and the fore femur with a broad preapical whitish band. More important characters are described in the key. Apical sternite of male with a deep V-shaped incision in middle of hind margin; margin of hypopygium without a spine. Venation of forewing as in Plate 4, fig. 39.

Length, 14 to 15 millimeters.

Holotype, female, allotype, 1 male and 3 female paratypes, Kuala Lumpur, F. M. S., Batu Caves, September 9 and 15, 1921, and May 6, 1923 (*Pendlebury*).

The insects of the genus *Bagauda* seem to have a liking for caves; two cavernicolous species have previously been described; namely, *B. tenebricola* Horvath[10] and *B. cavernicola* Paiva (Assam),[11] from both of which the present species is evidently distinct.

[10] Bull. Mus. d'Hist. Nat. Paris 16 (1910) 271 (East Africa).

[11] Rec. Ind. Mus. 16 (1919) 350–377, pls. 34–36.

Bagauda brunneus sp. nov.

Female.—Smaller than *B. lucifugus*, differing as stated in key and as follows: Mid and hind tibiæ narrowly pale at base, but the remainder of femorotibial articulation brownish. Venation of forewing as in Plate 4, fig. 38. Length, 9.5 millimeters (*B. avidus* is 14 to 15 millimeters).

MINDANAO, Lanao, Kolambugan, holotype (*Baker*).

Genus PLOIARIA Scopoli

Key to the subgenera and species of Ploiaria Scopoli.

1. Transverse impression of head with its extremities at about middle of eyes but curved backward so that its median part lies nearly as far posteriorly as any part of eyes (Plate 4, fig. 41); apparent posterior margin of prosternum as seen from below entire and convex posteriorly; discal cell of forewing four times as long as apical vein (Plate 4, fig. 40). *Megaploiaria* subg. nov.
   Subgenotype, **P. (M.) fusca** sp. nov.

   Transverse impression of head otherwise; apparent posterior margin of prosternum as seen from below more or less depressed and appearing emarginate in middle; discal cell of forewing shorter relative to apical vein .... 2.
2. Transverse impression of head with its extremities near anterior margins of eyes, slightly convex posteriorly; posterior lobe of head with a stout bilobate dorsal tubercle; pronotum with two laterally projecting short tubercles just behind head, and two less-pronounced elevations just in front of median constriction, hind margin bisinuate; mesonotum with two more-prominent conical tubercles near posterior margin of disk; scutellum (apparently also part of the mesonotum) and basal abdominal tergite each with a long slender spine (Plate 3, fig. 36). *Gnomocoris* subg. nov.
   Subgenotype, **P. (G.) spinosa** sp. nov.

   Transverse impression of head almost straight across between middle of eyes; head, thorax, and base of abdomen without tubercles or spines .... 3.
3. Fore trochanters each with at least one rather strong spine or bristle; combined length of fore tibia and tarsus (in the present species) fully as great as that of fore femur. Subgenus *Ploiaria* Scopoli.... 4.

   Fore trochanters without bristles, at most with some very short fine hairs; combined length of fore tibia and tarsus distinctly less than that of fore femur. Subgenus *Luteva* Dohrn .... 5.
4. Length of discal cell of forewing subequal to that of the vein emitted from apex of the cell (Plate 4, fig. 44); apices of hind femora and bases of hind tibia broadly white .... **P. (P.) subaequalis** sp. nov.

   Length of discal cell of forewing about twice as great as that of vein emitted from apex of the cell (Plate 4, fig. 45); hind femora and tibiæ uniformly brownish .... **P. (P.) uniformis** sp. nov.

5. Some, usually dark, transverse veinlets in the cell proximad of the discal cell (Plate 4, fig. 46); mid and hind femora without an outstanding preapical dark band .... 6.
   No transverse veinlets in the cell proximad of the discal cell; width of eye much less than interocular space; mid and hind femora each with a conspicuous broad fuscous preapical band.
   P. (L.) mellea sp. nov.
6. Males .... 7.
   Females .... 10.
7. Apex of hypopygium with a distinct central spine .... 9.
   Apex of hypopygium without a central spine .... 8.
8. (Four alternatives.) Apex of hypopygium merely angulate, the apex recurved and slightly emarginate (Plate 4, fig. 48).
   P. (L.) apicata sp. nov.
   Apex of hypopygium nearly straight across (Plate 4, fig. 49).
   P. (L.) recta sp. nov.
   Apex of hypopygium slightly emarginate (Plate 4, fig. 51); stigma rufous beyond cross vein .... **P. (L.) media sp. nov.**
   Apex of hypopygium deeply emarginate (Plate 4, fig. 54); stigma not rufous .... **P. (L.) ultima sp. nov.**
9. Spine of hypopygium set distinctly within posterior margin (Plate 4, fig. 50); fuscous species, with apices of mid and hind femora darker.
   P. (L.) bakeri sp. nov.
   Spine of hypopygium a continuation of posterior surface (Plate 4, fig. 53); testaceous species, with apices of mid and hind femora paler.
   P. (L.) nitida sp. nov.
10. Transverse thickening of membrane of hind wing narrow (Plate 4, fig. 52) .... 11.
    Transverse thickening of membrane of hind wing broad (Plate 4, fig. 47) .... 12.
11. Pronotum highly glossy, the fine pubescence difficult to see; mesonotum with fine barring laterally .... **P. (L.) zebrina sp. nov.**
    Pronotum subshining, the fine pubescence obvious; mesonotum without barring .... **P. (L.) ultima sp. nov.**
12. Pronotum highly glossy, the fine pubescence difficult to see.
    P. (L.) apicata sp. nov.
    Pronotum subshining, the pubescence obvious.... **P. (L.) nitida sp. nov.**

Ploiaria (Megaploiaria) fusca sp. nov.

Male.—General color blackish brown, bases of antennæ, tylus, two short lateral and one longer median vitta on anterior lobe of head (Plate 4, fig. 41), marmorations, mostly median, on pronotum, three narrow vittæ on disk and margins of mesonotum, costa basally, spiracles, marmorations on venter, mid and hind trochanters, bases and apices, and indistinct annuli on shaft of femora, and basal annuli on tibiæ yellowish. Forewing fuscous, without pale markings.

Basal segment of antenna with moderately long erect hairs, tylus evident from side view, longer from antennal insertion

than head is from that point to eye; seventh tergite convex apically; sixth sternite almost straight in middle, more or less emarginate laterally; wings a fourth shorter than abdomen; transverse thickening of hind wing very broad, nearly straight-sided, and blackish; apex of hypopygium with a broad process which is shallowly angularly emarginate in center (Plate 4, fig. 42); claspers terete, incurved and acute apically. Venation of forewing as in Plate 4, fig. 40.

Length, 19 millimeters.

MINDANAO, Surigao, Surigao, holotype (*Baker*).

The fore legs are missing in the specimen described, and we may err in assigning it to *Ploiaria*, with which it agrees however in general structure of thorax, in venation, and in the possession of the transverse thickening in the hind wing.

Ploiaria (Gnomocoris) spinosa sp. nov.

Female.—Dark brown, shiny, pronotum variegated with pale yellowish; mesonotum with four round spots along each margin and some on disk, yellowish, upper margin of pleura stramineous. Antenna dark brown, basal two segments with many narrow pale annuli. Fore legs dark brown, variegated with yellowish, more prominently so at middle, femora each with two irregular annuli, one just beyond middle, the other at apex, tibiæ and tarsi each with three pale annuli, one at base, one at middle, and the other at tip, the latter not complete on tibiæ; mid and hind legs testaceous, copiously dotted and subannulate with pale brown, a narrow preapical annulus and a broader apical band on each femur, and a narrow stripe near base of each tibia, blackish. Wings brown, with series of rounded to subquadrate hyaline spots in each cell, close to veins and separated by brown lines (Plate 4, fig. 43).

Head, thorax, and fore legs as in Plate 3, fig. 36; note the snoutlike prolongation of head in front of antennal insertions, the corrugate fore coxa, the undulate fore femur, a few basal spines of the armature much stronger than the others, and the trisinuate posterior margin of pronotum. Antennæ with only minute appressed hairs, third and fourth segments subequal. A laterally projecting tubercle each side of apex of tylus. Constriction of pronotum more pronounced than usual in the genus, and farther removed from posterior end of the segment; mesonotum sulcate in center. Venation of apical part of forewing as in Plate 4, fig. 43; transverse thickening of hind wing broad and curved.

Length, 8 millimeters.

BORNEO, Sandakan, holotype (*Baker*).

Despite its unusual tubercles and spines, this species fits well in the large genus *Ploiaria,* agreeing in wing venation and texture, including the transverse thickening of hind wing, as well as in the fundamental structure of thorax and fore legs.

Ploiaria (Ploiaria) subaequalis sp. nov.

Male.—General color testaceous, antennæ and hind legs fuscous, the femorotibial joints ivory colored; forewings with the veins fuscous, and sparse, transverse dusky irrorations (Plate 4, fig. 44), which appear in the iridescent membrane like watermarks in silk.

Antenna with soft hairs, more or less erect basally, but appressed apically; fore femora with mixed long and short spines, the former curved, but neither so strongly curved nor so contrasted in size with the shorter spines as is the case in some of the American species; fore trochanter slightly pointed-tuberculate beneath, with one long and one short spine; mesonotum with a median impressed line; transverse thickening of hind wing rather broad and curved; venation of forewing as in Plate 4, fig. 44; hind margin of hypopygium with two slender, erect, acute spines; claspers lanceolate, incurved, and acute apically.

Length, 6 millimeters.

LUZON, Laguna, Los Baños, holotype (*Baker*).

Ploiaria (Ploiaria) uniformis sp. nov.

Female.—General color testaceous, eyes black, basal segment of antenna blackish, mid and hind legs brownish; forewings yellowish hyaline, the veins darker, an oblong dark spot in middle of discal cell, and in next distal cell along costa (Plate 4, fig. 45); apical cross vein overlaid by a narrow dusky marking; stigma reddish apically.

Basal segment of antenna not noticeably hairy; fore trochanter rounded beneath, with a single spine; armature of fore femur rather uniform, no outstanding spines; pronotum and mesonotum each with a median impressed line; mid and hind femora slightly clavate. Apical venation of forewing as in Plate 4, fig. 45.

Length, 6.5 millimeters.

MINDANAO, Surigao, Surigao, holotype (*Baker*).

Examination of such species as this and the preceding shows that there is no real dividing line between the groups *Ploiaria*

and *Luteva*. All gradations in the trochanteral and femoral armature exist; and in other characters the groups agree so closely that they appear best placed in a single comprehensive genus.

Ploiaria (Luteva) mellea sp. nov.

Female.—Body dark, antennæ and legs pale honey color; forewings stramineous, dusky along margins and veins, hyaline in cells. First and second segments of antenna with a fuscous subapical and a whitish apical annulus, third segment dusky, with pale apex, fourth entirely dusky. Mid and hind femora with a subapical and tibiæ with a subbasal brownish band or spot, in each case there is a smaller spot nearer the articulation; segments of fore legs more or less brownish beneath, the markings tending to form three half annuli on femur, and to cover the entire apex of tibia.

Body, antenna, and legs with abundant short, pale pubescence, rather erect on pronotum and mesonotum; each of these divisions with a median impressed line.

Length, 12 millimeters.

LUZON, Laguna, Mount Maquiling, holotype female, and paratype, without abdomen (*Baker*).

Ploiaria (Luteva) apicata sp. nov.

Male and female.—Body, antennæ, and legs stramineous to testaceous, wings whitish to yellowish hyaline. First segment of antenna with a whitish subapical annulus, second narrowly whitish at base and apex. Fore coxa and tibia more or less infuscated, femur with three more or less distinct fuscous annuli. Mid and hind femora each with subapical whitish annulus, the femorotibial joint broadly whitish, with subarticular brownish spots or narrow annuli. Veins of forewing darker, transverse ones with narrow dusky clouding (Plate 4, fig. 46).

Antenna of male with long spreading hairs basally, decreasing in length gradually to apex of second segment; third and fourth segments with fine appressed pubescence. Mesonotum with a median impressed line. Thickened part of hind wing as in Plate 4, fig. 47. Apex of hypopygium as described in key (Plate 4, fig. 48); claspers terete, incurved, acute.

Length, 10.5 to 12.5 millimeters.

BORNEO, Sandakan, holotype male, allotype female, and 15 paratypes (*Baker*).

Ploiaria (Luteva) recta sp. nov.

Male.—General color stramineous, tinged with reddish, especially on fore legs, where it tends to form annuli on femora. Antenna and hind femur without pale annuli. Forewing whitish hyaline, with a vein from base to near middle, and apical part of stigma, reddish; other veins and cross veinlets fuscous, narrowly dusky margined, a dark dot between costa and apex of discal cell.

Antenna with long hairs basally, as usual in males of the group. Mesonotum with a longitudinal median impression. Hind margin of hypopygium straight between claspers, the latter lanceolate, incurved, and acute (Plate 4, fig. 49).

Length, about 11 millimeters.

MINDANAO, Surigao, Surigao, holotype (*Baker*).

Ploiaria (Luteva) media sp. nov.

Male.—Colored much like *P. recta,* but with both the reddish and the dusky markings fainter; apex of hypopygium as in Plate 4, fig. 51; claspers terete, incurved, acute.

Length, about 10 millimeters.

LUZON, Laguna, Mount Maquiling, holotype (*Baker*).

Ploiaria (Luteva) ultima sp. nov.

Male and female.—General color testaceous, mid and hind femorotibial joints whitish, with included spots or faint limiting annuli, dusky. Basal transverse veinlets and veins of forewing dusky, membrane yellowish hyaline.

Antenna of male with long spreading hairs basally, shorter and appressed ones apically. Thickened part of hind wing as in Plate 4, fig. 52. Apex of hypopygium as in Plate 4, fig. 54; claspers terete, incurved, and acute.

Length, 10 to 13 millimeters.

Holotype male, allotype, and 18 paratypes, Mount Maquiling, Luzon; paratypes, Malinao, Tayabas; Los Baños, Laguna; Cuernos Mountains, Negros (*Baker*).

Ploiaria (Luteva) bakeri sp. nov.

Male.—Head fuscous above, piceous below; thorax castaneous above, piceous below; abdomen piceous. Basal two segments of antenna with testaceous and dusky annuli, darkest near extremities; apical two segments fuscous. Beak banded. Fore coxa piceous, with some yellow markings on dorsal surface near apex; trochanter piceous; femur piceous beneath, marbled with

fuscous on basal half of upper surface, and with a subapical fuscous annulus; tibia piceous, with subbasal pale annulus; tarsus piceous, pale at each extremity. Mid and hind femora castaneous, slightly mottled with yellowish, each with a subapical annulus of the same color; tibiæ of these legs testaceous, each with a pale annulus bordered by two fuscous ones near base. Dusky transverse markings of forewing distinct and occurring almost throughout the whole length of the wing; a distinct piceous spot near base of discal cell.

Antenna haired as usual in males of the genus. Hypopygium as in Plate 4, fig. 50.

Length, 10.5 millimeters.

MINDANAO, Surigao, Surigao, holotype (*Baker*).

Ploiaria (Luteva) nitida sp. nov.

Male and female.—General color stramineous to testaceous, antennæ dusky apically, head brownish, glossy; pronotum highly polished, mesonotum somewhat duller; femorotibial joints of mid and hind legs whitish, the segments reddish tinged near by, giving the effect of a subapical pale annulus on femur. Forewing hyaline, most of the longitudinal veins yellowish, the transverse veins and veinlets dusky, and a dusky spot or vitta in inner cell near apex.

Hypopygium as in Plate 4, fig. 53.

Length, 11 to 13 millimeters.

Holotype male, allotype, and 17 paratypes, Surigao, Mindanao; paratypes, Butuan; Davao, Iligan, Mindanao; Basilan (*Baker*).

Ploiaria (Luteva) zebrina sp. nov.

Female.—General color testaceous, the legs paler, the head, thorax beneath, and abdomen darker; mid and hind femorotibial joints whitish. Costal and radial margins of forewing yellowish, the veins otherwise fuscous, margined with dusky, transverse veinlets dusky.

Length, 12 millimeters.

NORTHWESTERN PANAY, holotype (*Baker*).

Genus **ISCHNONYCTES** Stål

Ischnonyctes alatus Distant.

Ischnonyctes alatus DISTANT, Fauna Brit. Ind. Rhynchota 2 (1904) 217, fig. 153 (Ceylon).

One male specimen from Mount Maquiling, Luzon (*Baker*), answers to Distant's description, so we are using his name provisionally. The genitalia agree with those of *I. marcidus* Uhler,[12] of which form *I. alatus* may be only the winged male.

Genus ISCHNOBAENA Stål

Ischnobaena macerrima Stål.

Ischnobaena macerrima STÅL, Öfv. Kgl. Vet.-Akad. Förh. 27 (1870) 703 (Philippines).

Ischnobaena dohrnii STÅL, op. cit. pp. 703, 704 (Philippines).

We identify as this species a specimen from Mount Maquiling, Luzon (*Baker*); its characters differ from those mentioned in the original description as follows: Less contrasted in coloration, the general color being castaneous, the fore tibia with a broad pale annulus at middle, the mid and hind tibiæ with two indistinct pale annuli on basal third, and each of the tergites except first with a pale blotch near each anterior angle. Such pale markings are not likely to be very constant and, since differences in them were the only distinctions pointed out in Stål's original descriptions, his two names may apply to a single species. In the specimen before us, a female, the last tergite is triangular, with the sides declivate, forming a lidlike structure; the sternites from 2 to 5 are emarginate medianly, least so on 5, and they are traversed by a median line which upon 6 is elevated and prolonged upon a moderate triangular median process.

Length, 34 millimeters.

Genus PHRYXOBOTRYS novum

In the structure of the fore leg (Plate 4, fig. 55) this genus is most like the subgenus *Ploeodonyx* in *Ghilianella*. However, it differs from that group in having the fore tarsal claw half as long as, and movably articulated with, the tarsus, and diverges from *Ghilianella* in general in the lack of denticles on underside of fore tarsus (which is merely serrulate and provided with two rows of setulæ) and fore tibia (which is long setose), in the lack of a frontal prominence or spine, and in the polished character of its whole surface; there being no granulations as frequently is the case in *Ghilianella*. The armature of the fore femur (Plate 4, fig. 55) is highly characteristic, being confined to somewhat less than the distal half of the undersurface, and consisting in the main of a single row of sharp spines, which

[12] *Emesa marcida* Uhler, Proc. U. S. Nat. Mus. 19 (1896) 273 (Japan).

are situated on almost the median ventral surface; there is a long spine close to the base of this series (and near apex of opposed tarsus) which is situated on the anteroventral surface, and basad of this a series of three long spines which runs obliquely across the vental surface, directed obliquely forward over tarsal claw.

Notwithstanding these differences and the notably small size (less than half the length of any described species), it is not improbable that intergrading forms may be found that will make it desirable to regard this segregate as a subgenus of *Ghilianella.*

Genotype, the following new species:

Phryxobotrys castanea sp. nov.

General color of head and body dark castaneous, with a pale spot on middle of hind margin of mesonotum and of metanotum; first tergite pale anteriorly, and a pale spot on connexivum of each abdominal segment. Fore leg pale castaneous, the articulations paler; mid and hind legs testaceous, with a faint dark annulus each side of the pale femorotibial joint. Antenna testaceous basally, darker apically.

Entire surface of head and body highly polished. Mesonotum and metanotum each with margins and a median carina moderately roundedly elevated; their posterior angles rounded. Abdomen clavate, attaining its greatest width at about the juncture of segments 3 and 4 and narrowing very little posteriorly; eighth tergite narrowly semielliptical, ninth truncate triangular, rounded apically; seventh sternite somewhat produced and rounded medianly, slightly emarginate laterally. Fore coxa nearly as long as fore femur.

Length, 6 millimeters.

LUZON, Laguna, Mount Maquiling, holotype female (*Baker*).

BIBLIOGRAPHY

BERGROTH, E. Novum genus Ploeariinarum. Revue d'Entomologie **22** (1903) 12, 13.

Bagauda g. nov., monobasic, genotype *B. avidus* sp. nov. [Bombay]. "The name of the genus is masculine."

BERGROTH, E. Zur Kenntnis der Ploeariinen. Verh. K. K. zool.-bot. Gesell. Wien **56** (1906) 305–321.

Luteva funebris sp. nov. [Borneo], pp. 310–311; *Lutevopsis muscicapa* sp. nov. [Borneo], pp. 311, 312; notes that *Emesa marcida* Uhler is an *Ischnonyctes* of which *I. praedicator* Kirkaldy is a synonym.

BERGROTH, E. Some Javanese Hemiptera collected by E. Jacobson and Th. H. MacGillavry. Zool. Meded. Leiden No. 2 1 (October, 1915) 109–123.

Luteva culicina sp. nov., pp. 109–111; *Gardena semperi* Dohrn, p. 111; *G. brevicollis* Stål, p. 111; *Gomesius insaturabilis* sp. nov., pp. 111–113; *Ischnonyctes pennatus* sp. nov., pp. 113, 114.

BREDDIN, G. Rhynchoten von Ceylon, gesammelt von Dr. Walter Horn. Ann. Soc. Ent. Belg. 53 (1909) 250–309, figs. 1–27.

Bagauda decorus sp. nov., pp. 301, 302; *Lutevula lutea* g. and sp. nov., pp. 303, 304, fig. 26.

DISTANT, W. L. Undescribed oriental Rhynchota. The Entomologist 36 (January, 1903) 1, 2.

Luteva feana sp. nov. [Burma], p. 1.

DISTANT, W. L. Rhynchotal notes. XVI. Heteroptera: Family Reduviidae (continued), Apiomerinae, Harpactorinae, and Nabinae. Ann. & Mag. Nat. Hist. VII 11 (1903) 245–258.

Stenolaemus greeni sp. nov. [India, Ceylon], p. 256; *S. atkinsoni* sp. nov. [India], p. 256.

DISTANT, W. L. The Fauna of British India, Rhynchota (Heteroptera) 2 (1904) 200–217.

Ploiariola oculata Reuter [Ceylon], p. 202, fig. 141; *Stenolaemus crassirostris* Stål [Ceylon, Philippines], p. 203, fig. 142; *S. greeni* Distant [India, Ceylon], pp. 203, 204; *S. atkinsoni* Distant [India], p. 204; *Myiophanes greeni* sp. nov. [Ceylon], p. 205, fig. 143; *M. karenia* sp. nov. [Burma], pp. 205, 206, fig. 144; *Eugubinus araneus* Distant [Uran], pp. 206, 207, fig. 145; *Bagauda avidus* Bergroth [Bombay, Ceylon], p. 208, fig. 146; *Luteva feana* Distant [Burma], p. 209, fig. 147; *Ploiaria greeni* sp. nov. [Ceylon], pp. 209, 210, fig. 148; *Ghilianella phasma* sp. nov. [Burma], p. 211, fig. 149; *Gomesius predatorius* g. and sp. nov. [Ceylon], p. 212, fig. 150; *Ischnobaena macerrima* Stål [Ceylon, Philippines], pp. 213, 214, fig. 151; *I. henrici* Dohrn [Ceylon], p. 214; *Gardena bicolor* sp. nov. [Burma], pp. 214, 215, fig. 152; *G. melinarthrum* Dohrn [Ceylon], p. 215; *Emesa ? invisibilis* Dohrn [Ceylon], p. 216; *Emesa filum* Fabricius [East India], p. 216; and *Ischnonyctes alatus* sp. nov. [Ceylon], p. 217, fig. 153.

DISTANT, W. L. Oriental Reduviidae. Ann. & Mag. Nat. Hist. VII 18 (1906) 363–371.

Ploiariola pygmaea sp. nov. [Ceylon], p. 363; *Bagauda splendens* sp. nov. [Ceylon], p. 364; *Guithera* g. nov. orthotype *Luteva feana* Dist., p. 364; *G. hortensia* sp. nov. [Ceylon], pp. 364, 365; *G. nubifera* sp. nov. [Ceylon], p. 365.

DISTANT, W. L. Oriental Rhynchota, Heteroptera. Ann. & Mag. Nat. Hist. VIII 3 (1909) 491–507.

Ploiariola mixta sp. nov. [Ceylon], pp. 501, 502; *P. polita* sp. nov. [Ceylon], p. 502; *Calphurnia reticulata* g. and sp. nov. [Calcutta, Ceylon], pp. 502, 503; *Calphurnia ? aberrans* sp. nov. [Ceylon], pp. 503, 504; *Elymas praesentans* g. and sp. nov. [Ceylon], pp. 504, 505; *Ploearia anak* sp. nov. [Lucknow], p. 505; *Gardena fasciata* sp. nov. [Ceylon], pp. 505, 506.

DISTANT, W. L. The Fauna of British India, Rhynchota. 5 Heteroptera: Appendix (1910) 171–182.

Ploiariola pygmaea Distant [Ceylon], p. 171; *P. mixta* Distant (a *Tridemula*) [Ceylon], p. 172, fig. 93; *P. polita* Distant [Ceylon] pp. 172, 173, fig. 94; *Calphurnia reticulata* Distant [Calcutta, Ceylon], pp. 174 , 175, fig. 95; *Calphurnia ? aberrans* Distant [Ceylon], pp. 175, 176, fig. 96; *Bagauda splendens* Distant [Ceylon]; *Guithera hortensia* Distant [Ceylon], p. 177; *G. nubifera* Distant [Ceylon], p. 177; *Luteva malayana* Distant [Ceylon: Siamese Malay States], pp. 177, 178, fig. 97; *Elymas praesentans* Distant [Ceylon], pp. 179, 180, fig. 98; *Ploearia anak* Distant [Lucknow], pp. 180, 181, fig. 99; *Gardena fasciata* Distant [Ceylon], pp. 181, 182, fig. 100.

DISTANT, W. L. Reports of the Percy Sladen Trust Expedition to the Indian Ocean in 1905, Vol. V, Rhynchota, Part I: Suborder Heteroptera. Trans. Linn. Soc. London II, Zoology 16 (September, 1913) 139–191, pls. 11–13.

Ploiariola scotti sp. nov. [Seychelles], pp. 163, 164, pl. 12, fig. 2; *Calphurnia reticulata* Distant [Seychelles, India], p. 164; *Calphurnioides elongatus* g. and sp. nov. [Seychelles], pp. 164, 165, pl. 12, fig. 15a; *Stenolaemus madagascariensis* Westwood [Seychelles], p. 165; *Luteva malayana* Distant [Seychelles, Siam, Ceylon], p. 165; *Gardena seychellensis* sp. nov. [Seychelles], p. 165, pl. 12, fig. 5; *Roslania insularis* g. and sp. nov. [Seychelles], pp. 165, 166, pl. 12, fig. 7.

DOHRN, ANTON. Beiträge zu einer monographischen Bearbeitung der Familie der Emesina, Linnaea Entomologica 14 (1860) 206–252, pl. 1; Nachtrag, pp. 253–255.

Gardena melinarthrum sp. nov. [Ceylon], pp. 214, 215; *Emesa henrici* sp. nov. [Ceylon], pp. 218, 219; *E. invisibilis* sp. nov. [Ceylon], pp. 219, 220, pl. 1, figs. 3, 4, 7; *Luteva concolor* sp. nov. [Celebes], p. 243, pl. 1, fig. 25; and *Stenolemus fasciculatus* sp. nov. [Celebes], pp. 250, 251.

DOHRN, ANTON. Beiträge zu einer monographischen Bearbeitung der Familie der Emesina (Zweites Stück), Linnaea Entomologica 15 (1863) 42–63; Nachträge zur monographischen Bearbeitung der Emesina, pp. 64–76.

Stenolemus fasciculatus Dohrn [Celebes], fuller description than original, pp. 51, 52; *Gardena semperi* sp. nov. [Luzon], pp. 64, 65; and *Luteva longiventris* sp. nov. [probably from Sunda Islands].

HORVATH, G. Miscellanea Hemipterologica XV, Stenolaemaria nova. Ann. Mus. Nat. Hung. 12 (1914) 639–652, figs. 1–9.

Bironiola g. nov. orthotype *B. bullata* sp. nov. [New Guinea], p. 639, figs. 1, 2; *B. bullata* sp. nov. [New Guinea], pp. 639, 640, fig. 1; *B. mendosa* sp. nov. [New Guinea], pp. 640, 641, fig. 2; *Ploiariola sagax* sp. nov. [Madras], pp. 642, 643, fig. 4; *P. distinguenda* n. n. for *P. oculata* Distant not of Reuter [Ceylon], p. 643; *P. brachystigma* sp. nov. [Japan], pp. 644, 645, fig. 6; *Tridemula pilosa* g. and sp. nov. [New Guinea], pp. 645–647, fig. 7; *Hadrocranella imbellis* g. and sp. nov. [New Guinea], pp. 647–649, fig. 8; *Calphurnia pacalis* sp. nov. [Formosa], p. 649, fig. 9; *Calphurnioides aemula* sp. nov. [New Guinea], p. 650; *Stenolaemus papuensis* sp. nov. [New Guinea], pp. 651, 652.

KEMP, S., and W. E. CHINA. Rhynchota of the Siju Cave, Garo Hills, Assam. Rec. Ind. Mus. 26 (1924) 93–97.

Habits of *Bagauda cavernicola* Paiva, pp. 94–96; *Myiophanes kempi* China sp. nov. [Siju Cave], pp. 96, 97.

KIRKALDY, G. W. Two new Rhynchota (Reduviidae and Corixidae) from Japan, and diverse notes. The Entomologist 32 (1899) 78–80.

Ischnonyctes praedicator sp. nov., pp. 78, 79 (= *I. marcidus* Uhler).

KIRKALDY, G. W. Six new Reduviidae from Sumatra. Notes from the Leyden Museum, Note VI, 23 (July, 1901) 53–57.

Algol hesione g. and sp. nov., pp. 54, 55; *Hippokleides horsti* g. and sp. nov. [patria ignota], p. 55; *Ischnobaena polymela* sp. nov., pp. 55, 56; *Pleias ritsemae* g. and sp. nov., p. 56; *Luteva isadas* sp. nov., pp. 56, 57.

LETHIERRY, L., and G. SEVERIN. Catalogue Général des Hémipteres III (1896) 69–76.

Stenolaemus crassirostris Stål, *S. plumosus* Stål, *Luteva concolor* Dohrn, *Gardena brevicollis* Stål, *Gardena semperi* Dohrn, *Ischnobaena dohrni* Stål, and *I. macerrima* Stål recorded from the Philippines.

PAIVA, C. A. Rhynchota from the Garo Hills, Assam. Rec. Ind. Mus. 16 (1919) 350–377, pls. 34–36.

Bagauda cavernicola sp. nov. [Siju Cave], p. 366, pl. 36, fig. 3; *Myiophanes greeni* Distant, recorded from Tura, p. 366.

REUTER, O. M. Ad cognitionem Reduviidarum mundi antiqui. Acta Societatis scientiarum Fennicae 12 (1883) 271–339, 3 pls.

Myiophanes tipulina g. and sp. nov. [Japan], pp. 337, 338; *Ploearia oculata* sp. nov. [Ceylon], pp. 338, 339.

STÅL, C. Hemiptera insularum Philippinarum. Bidrag till Philippinska öarnes Hemipter-fauna. Öfv. Kgl. Vet.-Akad. Förh. 27 (1870) 607–776, pls. 7–9.

Stenolemus plumosus sp. nov., p. 702; *S. crassirostris* sp. nov., pp. 702, 703; *Ischnobaena* g. nov., p. 703 [two included species as follows]; *I. macerrima* sp. nov., p. 703, Plate 8, fig. 15; *I. dohrni*, pp. 703, 704; *Gardena semperi* Dohrn, p. 704; *G. brevicollis* sp. nov., p. 704; *Luteva concolor* ? Dohrn, p. 705.

UHLER, P. R. Summary of the Hemiptera of Japan, presented to the United States National Museum by Professor Mitzukuri. Proc. U. S Nat. Mus. 19 (1896) 255–297.

Orthunga bivittata sp. nov. (= *Myiophanes tipulina* Reut.), p. 272; *Emesa marcida* sp. nov. (=*Ischnonyctes*), p. 273.

ILLUSTRATIONS

Plate 1

FIG. 1. *Emesopsis* (*Hadrocranella*) *neptunis* sp. nov., forewing.
2. *Emesopsis* (*Hadrocranella*) *obsoletus* sp. nov., forewing.
3. *Emesopsis* (*Emesopsis*) *gaius* sp. nov., forewing.
4. *Emesopsis* (*Pseudobolos*) *emmesius* sp. nov., forewing.
5. *Emesopsis* (*Emesopsis*) *nero* sp. nov., discal cell of forewing.
6. *Emesopsis* (*Emesopsis*) *gaius* sp. nov., discal cell of forewing.
7. *Emesopsis* (*Pseudobolos*) *connexus* sp. nov., base of radius and adjoining veins of forewing.
8. *Emesopsis* (*Pseudobolos*) *emmesius* sp. nov., base of radius and adjoining veins of forewing.
9. *Emesopsis* (*Pseudobolos*) *velutinervis* sp. nov., base of radius and adjoining veins of forewing.
10. *Emesopsis* (*Hadrocranella*) *neptunis* sp. nov., fore coxa and femur, armature omitted.
11. *Emesopsis* (*Hadrocranella*) *obsoletus* sp. nov., fore coxa and femur, armature omitted.
12. *Emesopsis* (*Emesopsis*) *spicatus* sp. nov., fore coxa and femur, hairs and markings omitted.
13. *Emesopsis* (*Emesopsis*) *spicatus* sp. nov., apex of male hypopygium from side.
14. *Emesopsis* (*Emesopsis*) *spicatus* sp. nov., apex of male hypopygium from behind.
15. *Emesopsis* (*Emesopsis*) *nero* sp. nov., apical process of hypopygium from behind.
16. *Emesopsis* (*Pseudobolos*) *moniliferus* sp. nov., hypopygium of male from side.

Plate 2

FIG. 17. *Emesopsis* (*Hadrocranella*) *neptunis* sp. nov., hypopygium of male from side; *a*, apex of apical tergite.
18. *Emesopsis* (*Emesopsis*) *spicatus* sp. nov., hypopygium of male from side.
19. *Emesopsis* (*Emesopsis*) *gaius* sp. nov., hypopygium of male from side.
20. *Emesopsis* (*Emesopsis*) *gallienus* sp. nov., hypopygium of male from side.
21. *Emesopsis* (*Emesopsis*) *nero* sp. nov., hypopygium of male from side.
22. *Emesopsis* (*Emesopsis*) *hadrian* sp. nov., hypopygium of male from side.

PLATE 3

FIG. 23. *Ademula reticulata* sp. nov., forewing.
24. *Ademula reticulata* var. *abluta* var. nov., apex of male hypopygium from behind.
25. *Ademula nubecula* sp. nov., apex of male hypopygium from behind.
26. *Tridemula plurima* sp. nov., forewing, markings omitted.
27. *Tridemula plurima* sp. nov., apex of male hypopygium from behind.
28. *Tridemula pallida* sp. nov., apex of male hypopygium from behind.
29. *Tridemula plurima* sp. nov., ventral view of thorax and base of abdomen.
30. *Empicoris bilineatus* sp. nov., discal and adjoining cells of forewing.
31. *Empicoris bakeri* sp. nov., apex of male abdomen from below.
32. *Empicoris discalis* sp. nov., apex of male abdomen from below.
33. *Stenolemus plumosus* Stål, apex of hind femur and base of hind tibia.
34. *Myiophanes fluitaria* sp. nov., forewing.
35. *Myiophanes annulifera* sp. nov., forewing.
36. *Ploiaria* (*Gnomocoris*) *spinosa*, head, thorax, and base of abdomer from side.

PLATE 4

FIG. 37. *Gardena melinarthrum* Dohrn, hypopygium of male from side.
38. *Bagauda brunneus* sp. nov., forewing.
39. *Bagauda lucifugus* sp. nov., forewing.
40. *Ploiaria* (*Megaploiaria*) *fusca* sp. nov., apical part of forewing.
41. *Ploiaria* (*Megaploiaria*) *fusca* sp. nov., head from above.
42. *Ploiaria* (*Megaploiaria*) *fusca* sp. nov., apex of male hypopygium.
43. *Ploiaria* (*Gnomocoris*) *spinosa* sp. nov., apical part of forewing.
44. *Ploiaria* (*Ploiaria*) *subaequalis* sp. nov., apical part of forewing.
45. *Ploiaria* (*Ploiaria*) *uniformis* sp. nov., apical part of forewing.
46. *Ploiaria* (*Luteva*) *apicata* sp. nov., forewing.
47. *Ploiaria* (*Luteva*) *apicata* sp. nov., thickened part of hind wing.
48. *Ploiaria* (*Luteva*) *apicata* sp. nov., apex of male hypopygium.
49. *Ploiaria* (*Luteva*) *recta* sp. nov., apex of male hypopygium.
50. *Ploiaria* (*Luteva*) *bakeri* sp. nov., apex of male hypopygium.
51. *Ploiaria* (*Luteva*) *media* sp. nov., apex of male hypopygium.
52. *Ploiaria* (*Luteva*) *ultima* sp. nov., thickened part of hind wing.
53. *Ploiaria* (*Luteva*) *nitida* sp. nov., apex of male hypopygium.
54. *Ploiaria* (*Luteva*) *ultima* sp. nov., apex of male hypopygium.
55. *Phryxobotrys castanea* sp. nov., fore leg.

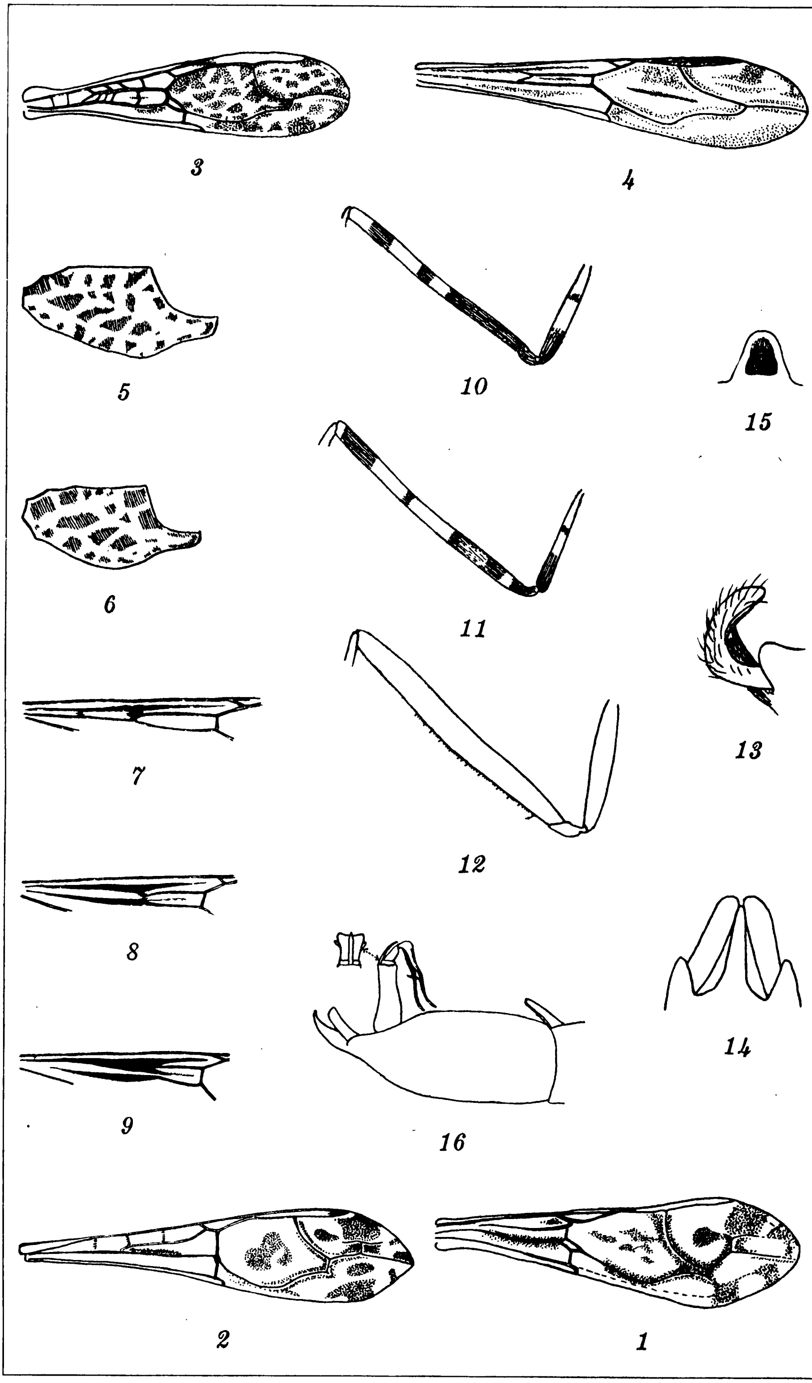
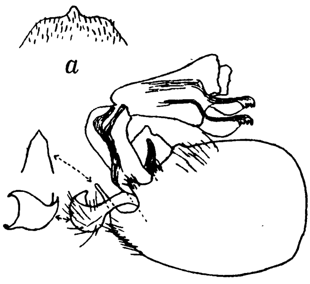
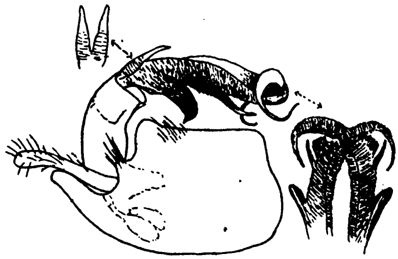


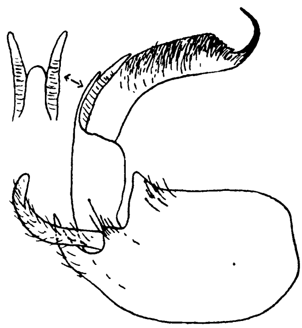
PLATE 1.



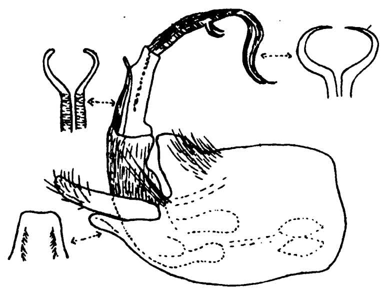
17



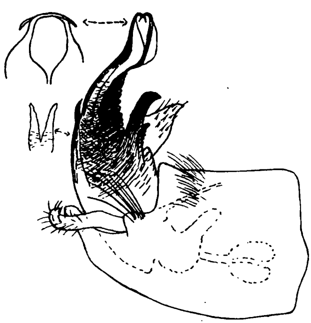
20



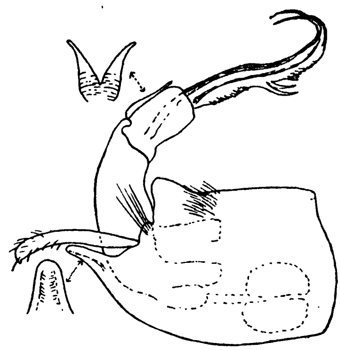
18



21



19



22

PLATE 2.

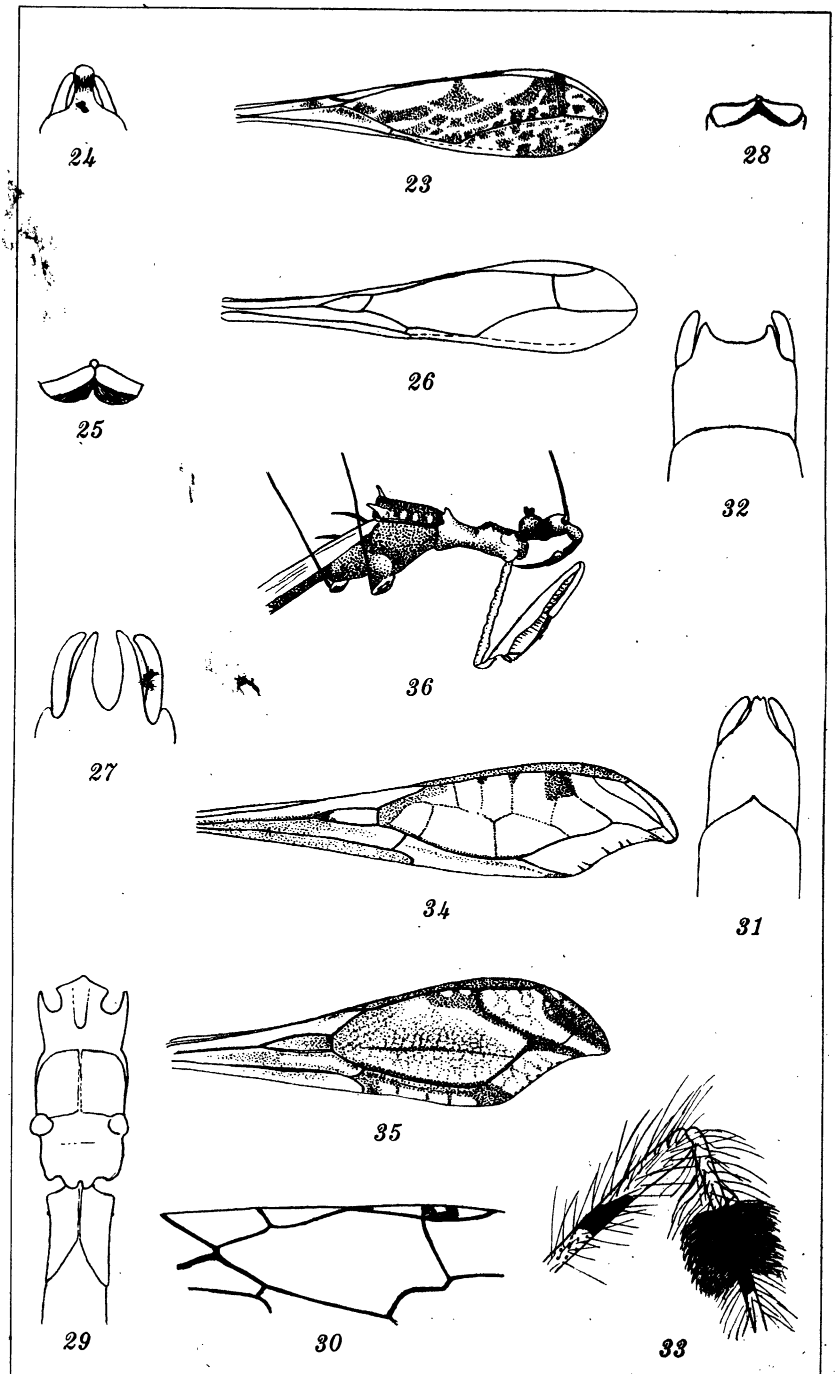


PLATE 3.

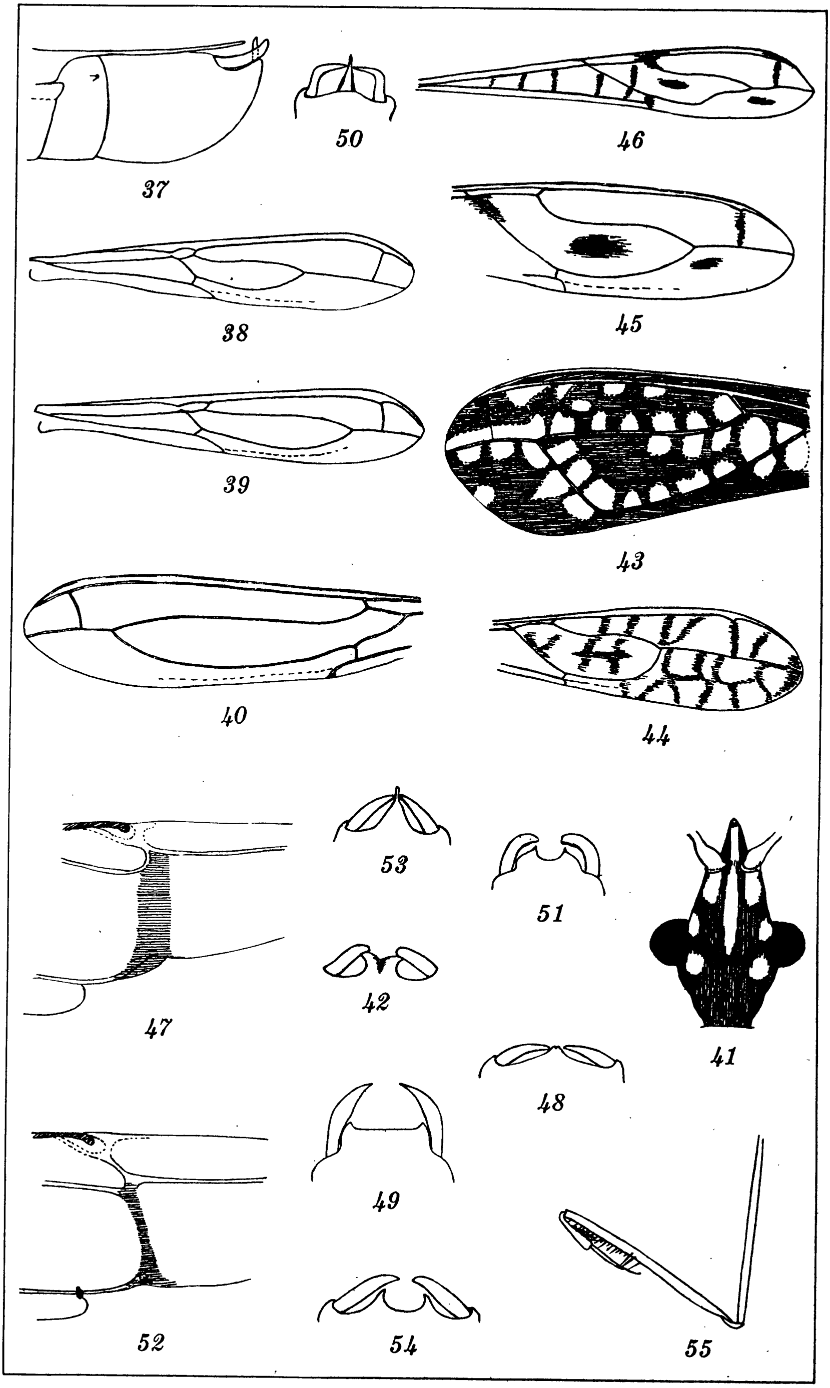


PLATE 4.

THE PHILIPPINE
JOURNAL OF SCIENCE

VOL. 30 JUNE, 1926 No. 2

HUGH CUMING'S LETTERS TO SIR WILLIAM J. HOOKER

By ELMER D. MERRILL
Of the University of California, Berkeley

ONE PLATE

The letters from Mr. Hugh Cuming to Dr. (later Sir) William Jackson Hooker, preserved in the latter's correspondence at the Royal Botanic Gardens, Kew, England, are thirty-three in number. They were written between the dates December 6, 1831, and January 21, 1858, some from London previous to Cuming's departure for the Philippine Islands, a few during his sojourn in the Islands, and the remainder after his return to England in June, 1840. These letters form a very human document and are in themselves an interesting commentary on the vicissitudes in the life of a field naturalist, both in the field and at home. Copies of these interesting letters were kindly prepared for me in 1910 by Sir David Prain, then director of the Royal Gardens, Kew. They are published here with the permission of Dr. A. W. Hill, the present director of the institution.

It is unfortunate that Cuming did not more fully describe his own experiences in these letters, but this may be accounted for by the fact that he was too busily engaged in collecting and preparing natural-history material in a very rich and previously unexplored field to take the time to write up his observations and experiences. A perusal of two letters, an undated one written from Thavies Inn, London, the latter part of 1840 or the early part of 1841 (p. 172), the other under date of May 25, 1841 (p. 173), clearly indicate that he did write an account of his experiences. The fate of this account is revealed in Cuming's letter of May 25, 1841, it falling in the category of

rejected manuscripts. Cuming's journal is probably no longer extant, but if it could be located it would to-day undoubtedly prove to be of very great interest to residents of the Philippine Archipelago, as well as to naturalists who are interested in studying the fauna and flora of the Islands. That he must have been a keen observer and that he must have had many interesting as well as some disconcerting experiences during the several years he was in the Philippines, owing to the primitive conditions then existing there, goes without saying.

We learn from Cuming's letters that he left England February 26, 1836, and returned June 5, 1840. He apparently reached Manila in October, 1836, as by November 10, 1836, he was busily engaged in prosecuting field work at Calauan, Laguna Province, Luzon. He left Manila on his return trip in November, 1839. In approximately three years, which he devoted to natural-history exploration in the Philippines, he prosecuted field work in most of the provinces in Luzon and visited nearly all of the larger islands in the Archipelago except Palawan, as well as some of the smaller ones.

As a collector, Cuming was primarily interested in securing conchological material, but his personal interests did not deter him from making more general collections such as mammals, birds, reptiles, insects, and crustaceans, as well as botanical material in most groups of plants. The only major fields he seems to have ignored are the marine and fresh-water fishes and representatives of those lower groups which in general are classed under the term marine invertebrates. This is probably explained by the fact that none of his associates in England requested him to secure such material. It is evident from his letters written before leaving England that he consulted numerous individuals previous to his departure with the view to determining what his friends and associates desired him to collect, and that when he was once in the field he diligently attempted to secure the material they desired in addition to conchological material, the securing of which was the prime object of his expedition to the Philippines.

Cuming's large collections of dried botanical material formed the essential basis of our knowledge of the rich flora of the Philippine Archipelago up to the beginning of the present century; in fact, in extent his collections have been surpassed by those of but very few individuals who have worked in this field during the past eighty years. Probably the collections made by no single individual can be considered as exceeding in value

those made by Cuming, in view of the fact that such a high percentage of his specimens became the types of new species. It is evident from an examination of the list of Cuming's plants that he followed Hooker's[1] advice and ignored those species growing in the vicinity of towns and along the seashore, and confined his field work very largely to the forested regions. The forests of the Philippines present a very high percentage of endemic species, while the vegetation of the settled areas and the open country is for the most part made up of very widely distributed forms; this statement applies also to all parts of the Malay Archipelago, and it is interesting to note that this fact was appreciated by Sir William J. Hooker, although he never personally visited the region. Cuming collected material representing not only the flowering plants and ferns, but also algæ, fungi, hepatics, lichens, and mosses. In addition to the dried material prepared by him he also sent extensive collections of living orchids to England.

Those familiar with the Philippine flora are impressed by the fact that very many common and widely distributed species are not represented in the Cuming collection. This is explained in part by the fact that to a considerable degree he ignored the littoral species and those growing in the open settled areas at low altitudes. The absence of many of the common and widely distributed endemic species characteristic of the forested areas is explained by the loss of a case of specimens referred to in his letter of November 18, 1838 (p. 168), and to the destruction of most of the material in seven cases by water, referred to in his letter of August 1, 1840 (p. 170).

The extent and value of the great collection of conchological material assembled by Mr. Cuming is well indicated by the following quotations from Sir Richard Owen's statement prepared in 1848.[2] This was addressed by him as Keeper of the Natural History Department of the British Museum to Dean Buckland, a trustee of the British Museum, when the collection was offered for sale but was not then accepted by that institution. The collection was greatly increased in the number of species represented, in the period of seventeen years that elapsed between this date and Mr. Cuming's death in 1865. It was purchased by the British Museum in 1866.

[1] See letter dated December 18, 1835, p. 166.

[2] Melvill, J. C., Journ. Conchol. **8** (1895) 65–68; see also Owen, R., Life of Sir Richard Owen **1** (1894) 313 et seq.

I may briefly state that this collection, as now offered to the British Museum, contains upwards of 19,000 species and varieties of shells, represented by about 60,000 specimens; and that not only is every specimen entire, but choice and perfect of its kind, as respects form, texture, colour, and other characters that give it value in the eyes of the shell-collector.

As I can affirm from my personal knowledge, and from authentic sources of information, that no public collection in Europe possesses one-half the number of species of shells that are now in the Cumingian collection, you may judge of the vast proportion of rarities and unique specimens possessed by Mr. Cuming. It is this which has given him for some years past the command, so to speak, of all the conchological cabinets in Europe. He is better known and respected, and his labours more truly and generally appreciated in any city or town in Europe having a public natural history museum than in busy London. Mr. Cuming in his annual visits to the continent carries with him the inferior duplicates of his rarities, representing species with the sight of which the eyes of the foreign naturalist are gladdened for the first time. They open to him their treasures in return, and from most of the collections of Europe Mr. Cuming has borne away the prized species or specimens in exchange for the still rarer and more valuable shells which his abundance has enabled him to offer without detriment to his own stores.

The mode in which Mr. Cuming has obtained this conchological wealth is as moral and exemplary as the result is important and marvellous, considered as the work of one individual. Not restricting his pursuit to the stores and shops of the curiosity-mongers of our seaports, or depending on casual opportunities of obtaining rarities by purchase, he has devoted more than thirty of the best years of his life to arduous and hazardous personal exertion, dredging, diving, working, wandering under the Equator and through the Tropics, the Temperate Zones, both north and south, in the Atlantic, in the Pacific, in the Indian Ocean, and in the islands of its rich Archipelago—in the labour of obtaining from native seas, shores, lakes, rivers, and forests, the marine, fluviatile, and terrestrial mollusca, 60,000 of whose shelly skeletons, external and internal, are accumulated in orderly series in the cabinets with which the floors of his house now groan. I never think of the casualities to which such a collection in such a place is subject without a shudder! ..... Perhaps one of the most striking points in the estimate of the scientific value of an extensive collection like Mr. Cuming's arises out of its relation to the present active pursuit of geology as an indispensable instrument to the determination of fossil shells. No one can give higher sanction than yourself to any expression of the importance of well-determined fossils, and especially shells, to a right knowledge of the relative age and position of the strata in which they were embedded; and the geologist's confidence in results based upon fossil conchology must be in the ratio of the extent of this comparison with recent shells that have been gone through in the determination of the fossil shells, and especially before a species is pronounced to be extinct.

This, however, is but one of its scientific uses. From the period when the Atlantic, American, and Polynesian departments of the Cumingian collection reached England, in 1831, scientific conchologists have there found subjects without intermission for their descriptions, and the novel-

ties were far from being exhausted when Mr. Cuming, having undertaken a third exploring voyage, returned in 1840 from Manila, stored with the conchological riches of the Indian Ocean, which have subsequently kept the pens of competent describers of new genera and species actively at work, and will supply them for years to come. Thus the Cumingian Collection has directly advanced the science of conchology in an unexampled degree, and possesses the same peculiar claims upon the Government as custodians of the National collection here which Linnaeus' Herbarium did upon the Swedish State. Mr. Cuming's collection contains, for example, the originals from which many hundred new species have been described in the scientific periodicals or systematic works published since its arrival in this country.

Any doubt that may arise through the incompleteness or obscurity of the description, or from the inaptitude of the student, may be decided at once by reference to the original specimens. These "types of the species" become, therefore, an instrument of great importance to the progress of the science in the country in which they are preserved and made accessible. Delay in securing for the nation the Cumingian types of new species of shells may involve the necessity of crossing the Atlantic in order to compare and verify the descriptions and synonyms of Broderip, Sowerby, Gray, Reeve, and other eminent conchologists.

The value of a shell, as of a jewel, depends much upon its rarity, and is to that extent artificial. The *Concha unica*, which today commands the sum of twenty pounds, shall, next week, when a score of specimens have come into the market, fall in price to as many shillings. Still, the commonest exotic shell, if it be perfect and well coloured, and taken from a living mollusk, as is the case with the Cumingian collection, from which "dead" shells have been strictly excluded, finds its market.

I am given to understand, by competent authorities, that the sum of £6,000 asked by Mr. Cuming in 1846 does not exceed two-thirds of the most moderate estimate of the present market value of his subsequently augmented collection.

That ten times that sum would not bring together such a series as Mr. Cuming has offered to the British Museum, I do firmly believe, from a knowledge of the peculiar tact in discovering and collecting, the hardy endurance of the attendant fatigue under deadly climes and influence, and the undaunted courage in encountering the adverse elements, and braving the opposition of the savage inhabitants of seldom-visited isles, which have conduced and concurred to crown the labours of Mr. Cuming with a success of which his unrivalled collection is a fitting monument, and of which science, and, let us hope, its cultivators in his native country more particularly, will long continue to reap the benefits.

Mr. W. J. Broderip [3] briefly summarizes the field work prosecuted by Cuming in the Philippines; his data are given on page 158. As noted in this account, Cuming was a pioneer in attaching exact locality data to the shells collected by him. In

[3] Description of shells collected in the Philippine Islands by Hugh Cuming, Esq., Proc. Zool. Soc. London 8 (1840) 83–84; reprinted in Ann. & Mag. Nat. Hist. 7 (1841) 226–227.

a sense, also, he was a pioneer in attaching numbers to the botanical material distributed by him, for his extensive *exsiccata* was apparently one of the first large collections of botanical material so distributed, a custom that soon became almost universal.

Mr. Cuming, the fruits of whose western voyage are so well known, left England on the 26th of February 1836: he proceeded to the Philippine Islands, by the permission of the Queen Regent of Spain and aided by powerful recommendations from her government, which opened to him the interior of the islands, and caused him to be received with a noble hospitality, equalled only by the warm interest which facilitated his pursuits wherever he arrived and made himself known.

Mr. Cuming visited the whole group. His longest stay was in the Island of Luzon, fifteen provinces of which were well ransacked by him. In the islands Mindoro, Negros, Panay, Siquijod [Siquijor], Zebu [Cebu], Bohol, Camiguing [Camiguin de Misamis], Mindanao, Leyte, Samar, Capul, Ticao, Masbate, Burias, Temple, Marinduque, Maracavan [Maricaban], and Romblon, he reaped a fine harvest. He left the Philippines in November, 1839, proceeded thence to Sincapore and Malacca, and returned to England in June, 1840, bringing with him, besides the living animals which he has liberally presented to this Society, a grand collection of zoological and botanical specimens, including more than three thousand species and varieties of shells, the greater part of which appear to be new to science, and among them are several new genera. The smaller islands were particularly rich in the pulmoniferous mollusca, which were found by Mr. Cuming principally in deep forests. We commence a notice of the labours of this active and zealous collector, with an attempt to describe a few of these terrestrial species. Mr. G. B. Sowerby, who liberally gives up his valuable time to assist in laying before the public the novelties of this part of the collection, will also begin his share of the task, by describing another branch of the same numerous family; and it is intended to submit descriptions to the Society from time to time till the whole of Mr. Cuming's stores are exhausted.

Before, however, we commence our task, I must, in justice to him who has placed the materials in our hands, observe, that, to say nothing of the variety of new forms which he has been the means of bringing to light, those who cultivate this branch of zoology so highly interesting to the geologist, as well as the physiologist, owe him a large debt of gratitude, for information on a point of no small zoological importance. It is not very long since, that the localities ascribed to shells could in very few instances be depended upon. The cupidity of dealers, some years ago, not unfrequently prompted them wilfully to deceive those who gave extravagant prices for new shells on this point, and carelessness was generally the order of the day. Mr. Cuming, by his accurate notes, and the open publication of the places where every one of the multitudinous species and varieties collected by him was found, has mainly assisted in making a complete revolution in this department of the science, and has done more towards giving us data for the geographical distribution of the testaceous mollusca than any person who has yet lived.

On the occasion of Cuming's death several biographical notices were published, the most extensive one that I have seen being that reproduced below.[4]

Hugh Cuming, Esq., F. L. S., died on the 10th of August, 1865. He was born at West Alvington, near Kingsbridge, in Devonshire, on the 14th of February, 1791. Remarkable even as a child for his love of plants and shells, the latter taste more especially was largely fostered and developed under the patronage of Colonel Montagu, who resided in the neighborhood.

Apprenticed to a sail-maker, he was necessarily brought into contact with seafaring men; and in 1819 he made a voyage to South America, and settled at Valparaiso. Here his passion for collecting shells found ample field for its gratification, and was greatly stimulated by the English Consul, Mr. Nugent, and by several officers of the British Navy, and especially by those in the surveying ships under Captains King and Fitzroy. In fact, in 1826, he gave up his business in order wholly to devote himself to his favorite pursuit. With this object he built a yacht, expressly fitted for the collection and stowage of objects of natural history, and a cruise of upwards of twelve months among the islands of the South Pacific amply rewarded him for his toils in dredging and collecting by sea and on shore. On his return to Valparaiso he prepared for a voyage of greater extent, on which he started under peculiar advantages. The Chilian Government granted him the privilege of anchoring in its ports free of charges, and of purchasing stores free of duty; and he was also furnished with letters to the authorities of all the states he visited. After two years spent in exploring the coast from the Island of Chiloe to the Gulf of Conchagua, dredging in all the bays and inlets, searching among the rocks and stones at low water, and inland in the plains, river-banks, and forests, Mr. Cuming returned to England with an enormous accumulation of natural history objects of all kinds. The most important part, however, was the conchological. In 1835 Mr. Cuming undertook a new expedition to the Philippine Islands, a region rich in natural productions, and but little explored, and where his familiar knowledge of the Spanish language and manners would be of great advantage. Here, although dredgings on the shores were not neglected, his attention was more particularly directed to the woods and forests, where he reaped a most abundant harvest of plants, and collected such an immense and magnificent series of land-shells as had never before rewarded the exertions of a collector. In every place Mr. Cuming was the guest of the priest, always the chief personage in the interior of these islands, and by whom he was always assisted in every imaginable way. He was also thus enabled to obtain what was of still greater importance, the services of the children educated in the public schools, and numbering

[4] Hugh Cuming, Esq., F. L. S., Journ. Linn. Soc. Zool. 9 (1868) LVII–LIX. See also Journ. Bot. 3 (1865) 325–326; Athenaeum (1865) 247–248; Gent. Mag. III 19 (1865) 517–519; Gard. Chron. (1865) 823–824; Dict. Nat. Biogr. 13 (1888) 295–296; Vidal Phanerogamae Cumingianae Philippinarum (1885) VII–X.

in some places as many as 400 or 500. By the aid of these sharp-eyed auxiliaries, shells which gladdened his eyes by their novelty and exceeding beauty were daily brought to him in prodigious numbers.

After four years spent among these islands [that is, an absence of four years from England, three of which were spent in the Philippines], and in short visits to Malacca, Singapore, and St. Helena, Mr. Cuming returned to England with the richest booty ever collected by a single man. His dried plants, which numbered 130,000 specimens, were immediately distributed, as well as his living Orchids, which were numerous and of great beauty. Large numbers of Birds and Reptiles, Quadrupeds and Insects, were added to museums at home and abroad. But the shells formed by far the most important part of his collections. Before leaving England he had brought together from his own American collections and elsewhere the largest and most valuable collection then in existence. By his vast Philippine collections this was increased to an enormous extent; and during the twenty-five years that have since elapsed he was untiringly engaged in its arrangement, completion, and description by various conchologists. It is stated to have contained not less than 30,000 species and varieties, and in most cases several specimens of each.

From time to time he disposed of his duplicate specimens to various public and private collections, and always took pleasure in acknowledging that his expenses and labours had been amply repaid.

"The great object of my ambition," he said in 1858, "is to place my collection in the British Museum that it may be accessible to all the scientific world, and where it would afford to the public eye a striking example of what has been done by the personal industry and means of one man."

This worthy object has been obtained, and the British Museum has since his death purchased this unrivalled collection, and placed it where its founder's wishes desired it to be.

The Linnaean Society, also, owes a special debt of gratitude to Mr. Cuming, who several years since presented to our Library his extensive collection of Conchological Works, into possession of which we have now entered.

Mr. J. C. Melvill [5] in 1895 published a short appreciation of Mr. Cuming's life and accomplishments from which the photograph illustrating this paper is reproduced. This article is supplemented by another in the same periodical by Mr. E. L. Layard,[6] on some personal recollections of Mr. Cuming. Mr. Layard's statements, "I do not think that he [Cuming] could do more than write his name" and "I have also said that I do not think that he [Cuming] could write," are refuted by Cuming's own letters. Of the thirty-three letters written by Mr. Cuming between December 6, 1831, and January 21, 1858, thirty-one were written by Cuming himself, two dated January 16 and

[5] An epitome of the life of the late Hugh Cuming, F. L. S., C. M. Z. S., etc., Journ. Conchol. **8** (1895) 59–70, plate.

[6] Op. cit. 71–75.

21, 1858, having been written by his daughter and signed by him. His handwriting is good and the few errors in spelling are probably due more to hasty writing than to ignorance. With his limitations as to education, it is all the more remarkable that Mr. Cuming was able to accomplish so much in the field of natural history, and especially in building up his enormous private collection of conchological material.

A bibliography of the papers based wholly or in part on Philippine collections made by Mr. Cuming would include many hundred titles, as the fields of general zoölogy, including conchology, entomology, ornithology, herpetology, and mammalogy would have to be covered, as well as that of systematic botany of both the phanerogams and the cryptogams. In practically all monographic treatments of genera and families which have been issued since 1840, so far as the numerous groups are represented in the great Cuming collections, his material is repeatedly cited and of necessity must continue to be cited because of its historical significance. A partial bibliography of papers based wholly or in large part on the Philippine material collected by Mr. Cuming is appended to this paper. No attempt has been made to make this bibliography complete, my object in compiling it being merely to give some graphic idea of the extent and scientific value of the collections assembled by this one man through his own initiative and on his own resources. In general no titles have been included where Cuming's material is merely mentioned. If this had been done, the list in botany alone would exceed six hundred titles.

A perusal of the following letters indicates that Cuming's education was deficient, yet his letters show that he was reasonably well educated. It is evident that he has attained more lasting fame than untold thousands of highly educated men; and it is also clear that his fame is more firmly established than is that of some authors of ponderous tomes and of numerous papers. Mr. Cuming apparently subordinated his own desires to a very large degree to the building up of his conchological collection. It is clear from his undated letter written from Thavies Inn (p. 172), and the following one written under date of May 25, 1841 (p. 173), that he had no illusions regarding his ability as an author. Would not some of our biological literature be of distinctly higher grade if more individuals had followed Cuming's plan of permitting and even encouraging others, presumably better equipped, to publish the results obtained by their field work?

Mr. Cuming was elected a Fellow of the Linnaean Society on May 1, 1832, and so remained until his death. His election was based not upon any data published by him, but apparently on the value of his services to the biological sciences as a collector, and further because of the fact that through his own efforts and on his own resources he built up the largest and most valuable conchological collection ever assembled by any one man or institution up to the time of his death. He personally published very little and most of the several references listed below are merely extracts from letters written by him, or references to letters received from him.

CUMING, H.

On the earthquake at Valparaiso in 1822. Proc. Geol. Soc. 2 (1838) 213–214.

On the earthquake in Chile, November 19th, 1822. Trans. Geol. Soc. 5 (1840) 263–265.

On the habits of some species of mammalia from the Philippine Islands. Proc. Zool. Soc. London 6 (1838) 66–68.

(Notice of) a letter dated Manila, December 24, 1836, accompanying a large box of skins of birds and quadripeds. Proc. Zool. Soc. London 5 (1837) 70.

(Notice of) a letter dated Manila, November 16, 1837, forwarding a collection of 295 birds and 12 quadripeds. Proc. Zool. Soc. London 7 (1839) 93.

(Notice of) a letter dated Manila, November 5, 1839, referring to the shipment of some cases of specimens. Proc. Zool. Soc. London 8 (1840) 33.

(Notice of) an exhibition of specimens. Proc. Zool. Soc. London 8 (1840) 62.

Mr. Melvill[7] lists the conchological genus *Cumingia* Sowerby and one hundred fifty-two species of mollusca dedicated by various authors to Hugh Cuming. In other zoölogical groups I find two birds, one turtle, one snake, five lizards, one mammal, and several insects named by various authors in honor of Mr. Cuming from his Philippine collections. In botany the genera *Cumingia* G. Don, based on South American material [=*Conanthera* Ruiz and Pav.], and *Cumingia* Vidal, based on Philippine material [=*Camptostemon* Masters], have been dedicated to him, while approximately one hundred forty species of plants have been described from his Philippine collections alone with specific names derived from that of this remarkable collector.

Of the thirty-three letters written to Sir William Jackson Hooker by Cuming, sixteen are reproduced below, as the re-

[7] Journ. Conchol. 8 (1895) 69, 70.

maining ones do not appertain to his Philippine experiences but refer to other matters.

79, CHARLOTTE ST., FITZROY SQ.,
London, Nov. 24, 1834.

DEAR SIR,

A Friend of mine having just returned from South America has made me a present of two Rock plants. From their appearance I think they are in Fruit. If they are worth your acceptance I shall be most happy as a Friend of yours informed me you had not one that was in Flower. Mr. Hunneman has kindly promised to forward them to you. I have been informed you have published a third part of my plants. If that is correct I shall feel most oblidged to you for it. Although not a Botanist I feel highly interested in possessing the work complete particularly as you have done me so much Honour in the kind manner you have there spoken of me. I have not had a letter from Mr. Brydges since I wrote you last. He is in the place I then spoke of near the Andes halfway betwixt Santiago and Conception. He ought there to make a fine collection. My Friend informs me Mr. Matthews left him some time since to pass the Andes from the pass near Truxillo and would collect on the Banks of the Maranan. He gave my Friend a few Ferns the like I never before saw they are very beautifull.

I shall feel most oblidged if you could gain any information in Glasgow or Grenock respecting Manilla and the Phillipine Islands, as it respects the Climate, State of Society amongst the lower classes and the Aborigines, or any information of the Civil Government towards strangers particularly those who might visit the place in Scientific Pursuits. At the same time please let me know if there has been any collectors of Natural History in those Islands or Botanists. I am still of a roving mind and should I gain anything like a satisfactory account of the place I have a great mind to pay it a visit for Two or Three years. Perhaps I might be able to render you some little service if it should not have been visited by a Botanist. From what I have learned here, nothing is hardly known respecting those Islands, all the shells from there are most beautifull and in England extremely rare. As I have not opened my mind to any one here, I beg you will not mention the subject to any person whatever as it would be more than a year before I could be ready to start, therefore I would not wish it to be known what my intentions where for the present; having received many kindnesses from your hands I hope I do not intrude by soliciting the above favour. Should I go I can only say you should have the preferance as before; when it is convenient I shall be most happy to receive an answer. If favourable I then will think about it in earnest.

I am Dear Sir
Most Oblid
to command
[Signed] H. CUMING

Dr. HOOKER,
Glassgow.

LONDON, *July 6, 1835.*

MY DEAR SIR,

I trust you will not think me ungrateful in not answering your most kind interesting letter of Decr. last, where you offered your Friendship If I went to India. I have duly matured upon a Collecting Voyage to that part of the World and would have written in answer long since If I had been sure I should have permission of the Spanish Court to visit the Philippine Islands as that place appears to be least known of any civilised part. I have now the promise of the Grant from the Spanish Ambassador through the Influence of Earl Derby and I trust ere long to have it in my possession. Accept my best thanks for your kind offers of letters of introduction. I shall feel greatly oblidged to you for them to any persons who may have interest in the Straits of Malacca, Sincapore, Penang, Canton, Java and Manilla as I think I shall visit all the above places and at the same time I shall be most proud to receive from your hands any instrUctions as it respects collecting of Plants &c. which you may think upon that I may be able to render you all and every Service that will lay in my power to execute; and at the same time you will confer a great favour by procuring for me as many Gentlemen who will be willing to take Collections of Plants from me on or befor my return at the same price as before. I have spoken to Mr. Brown and will also speak to Dr. Lindley and Mr. Bentham.[8] Perhaps you may be acquainted with some Gentlemen in London or this part of the kingdom who would be willing to add to their stores. If you would be pleased to give me their Names I will do myself the pleasure of waiting upon them or writing saying I have been recommended by you to make known my intentions &c.

I intend to leave England for Hamburg Copenhagen and Berlin on the 1st of August and will return to Town by the 1st of October and will finally leave England for the Indian seas by the first vessell after the New Year. I have to repeat how happy I shall be to receive any instructions, hints, and Letters of introductions from your hands and in return I will make the most complete Flora of those parts which I may visit that circumstances will admit of such as specimens, Fruits, and Woods. Realy I fear I am giving you a great deal of Trouble, but well knowing your great love for the Vegetable productions of all the World prompts me to ask the above favours in hopes of being able to make something like a return. I shall feel oblidged by an answer before the 1st of August saying what your Ideas are upon the subject perhaps you will not have time for the other subjects mentioned and there is not any hurry October will be time enough for them.

[Unsigned]

LONDON *July Six 1835*
Dr. HOOKER
Regius Professor Botany
Glasgow.

[8] Robert Brown, 1773–1758; John Lindley, 1799–1865; George Bentham, 1800–1884.—E. D. M.

LONDON *July 17—1835.*

MY DEAR SIR,

I had the pleasure to receive yours of the 9th and feel much oblidged for the many usefull hints you have given me therein. I can assure you nothing would induce me to have any thing belonging to me advertized. I merely intended, when I did myself the pleasure of writing you last to know if those Gentlemen who took Collections of my Chillian Collection would like to have from me on my return from the East. If I was to ask the public for Subscriptions, they would think I was in want of Cash. That I am proud to say is not the case in any degree beforehand. Under the above circumstances I should feel oblidged by your merely mentioning to your Botanical Friends when you meet them that I am going or gone to the Phillipine Islands and nothing more.

I have had a Letter from Mr. Fielding[9] of Lancaster requesting me to consider him a Subscriber. I have answered the Gentleman and he is put down the 7th on the List. I have done myself the pleasure to place your name on the Top of it. On my return from the Continent I will write you again by that time I shall be able to say what time I shall leave. As it respects the specimens I trust they will be better than the last. I will bring them large enough even to please Mr. Lambert.[10]

I am Dear Sir

Yours most sincerely

[Signed] H. CUMING

A few days since I had the pleasure to be introduced to a Friend of yours Mr. Harvey[11] of Limerick. He is a Conchologist as well as a Botanist. I gave him every information and written instructions how to collect shells and plants, the mode of packing them, &c. I found a most perfect Gentleman and most grateful for what Information I could give him. If I should call at the Cape he tells me I shall find a hearty welcome. I may touch at the Mauritius. I intend to visit Sincapore Malacca and Penang. At Malacca or near it is a most particular Fern of which there is but a small imperfect specimen in England. I will visit that place for that Fern alone. Mr. Brown has given me the above information. Do you know any Merchants at Glasgow who have a House at Manilla if so it would be a mutual advantage to both.

Yours most sincerely

[Signed] H. CUMING

LONDON: *July nineteen 1835*

Dr. HOOKER

Reg. Prof. Botany

Glasgow

LONDON. *Oct. 7th 1835*

MY DEAR SIR,

I had the pleasure to find your letter of the 28th of Sept. laying at my house on my return from the Continent for which I am much oblidged.

[9] H. B. Fielding, died 1851.—E. D. M.

[10] A. B. Lambert, 1761–1842.—E. D. M.

[11] W. H. Harvey, 1811–1866.—E. D. M.

When at Berlin Dr. Klotzsch gave me a parcel of plants for you which I have delivered to Mr. Hunneman who will forward them by Mr. M'Nab of Edinburgh on Saturday next with a specimen of an Aristolochia which is now in Flower at the Bot. Garden, Berlin, Dr. K. thence inclosed. In answer to yours respecting the places I intend to visit during my absence I will say Penang, Malacca, Sincapore and the Phillipines Islands to be the ostensible object I have hitherto in view but should vessell offer it is more than probable I shall also visit Timor Borneo and some of the adjacent Islands. Therefore I shall feel most particularly oblidged by all the Letters of Introduction you can procure for me for the Eastern Seas, not forgetting Macao [12] as it is probable I may call there.

I have made up my mind to quit London by the first *ship* after the New Year as I intend to be quite ready by the last day of the present year. You will confer a favour when you send me the Letters to give me a list, with particulars what you would wish me to collect besides the usual plants for you or any of your Friends. Mr. Brown, Mr. Stokes and some others have requested me to procure them things I should never have thought of and perhaps you may think of some things also. I shall pay due attention to the Mosses and Fuci. Some persons in Germany have also requested me to collect Fuci and Fungi. I will do my best endeavor to give satisfaction to all parties taking due care to give you a preference in everything you request me to collect. I have told them all I shall do so for Auld Lang Synge. I intend to collect seeds. Perhaps some of your Friends may like to have a collection

I hope the above will meet your approbation.

I am Dear Sir
Yours most Gratefull
to Command
[Signed] H. CUMING

Dr. HOOKER,
Regius Professor of Botany
Glasgow.

LONDON *Dec. 18, 1835.*

MY DEAR SIR,

Your most valuable packet came safe to hand, for which be pleased to accept my most sincere thanks and I trust your kind intentions will not be thrown away. Mr. Stokes had a few days before the arrival of your letters introduced me to Mr. Crawford [13] who has given me several letters to his Friends in India. I did myself the pleasure to write Mr. C. a note and inclosed yours to Him. Mr. Millet is living some place in Hampshire and having many letters to India perhaps it will not be necessary to trouble him on the subject. I feel most oblidged by your friendly hints and I will do all I can to perform the utmost of your wishes. Whenever an opportunity offers I will do myself the pleasure of informing you of my progress in the various branches of Natural History. Mr. Stokes has promised me letters for Macao. I expect to sail from Liver-

[12] These letters antedate the establishment of the Hongkong colony; Macao was then an important port.—E. D. M.

[13] Probably J. Crawford, orientalist, 1783–1868.—E. D. M.

pool on or about the 15th for Batavia Sincapore and Manilla. You say I must not collect plants near the Sea Coasts. I shall not be able to refrain from it knowing now a little of the plants so that I won't collect the same at every place I meet for I am of an opinion I may get plants on the Sea Coasts that has escaped the Eyes of all others. I did so in Chili and trust to do the same in the East and when I cannot collect plants with seeds and flowers at the same time I intend to collect them separate so that you shall be able to make them out. I have orders for all kinds of seeds with Branch &c.

If any vessell should sail from your port to Manilla for the next two years I should be most happy to hear from you it would afford me great pleasure to know what might occur in the Scientific World.

In expectation of having the best opportunity of a Collector and the Zeal of [an enthusiast? letter torn] during my voyage I shall be able to make you a return for the many favours received by bringing you a large Collection of new plants worthy of your notice and the first Choice.

I am Dear Sir
Yours most sincerely
Most Gratefull
[Signed] H. CUMING.

To Dr. HOOKER
Reg. Prof. Botany
Glasgow.

CALAGUAN, PROVINCE OF LAGUNA DE BAHIA
[that is, Calauan, Laguna Province]
LUZON *Nov. 10, 1836*

DEAR SIR,

Having the Honour to make the acquaintance of your Friend Mr. Maartens at this place I have done myself the pleasure of forwarding by him five specimens of plants to show you and my Friends that I am living and well in a perfect paradise having collected on this Estate alone 500 species of plants in Six Weeks besides innumerable species of Insects Shells and Reptiles. If convenient I should feel oblidged by your showing Messrs. Loddiges the Orchideae as I shall send him in Jan. next some living specimens. I presume the Ferns are new, to me they have given great pleasure in collecting them. I have taken nearly 50 species from this spot alone principally large ones.

My best respects to my Friends of the Linnean and say I shall be most happy to present an entire Collection of plants that I may collect in those Islands to the Society on my return.

I am Dear Sir
Yours Most Truly
[Signed] H. CUMING.

MANILA *Dec. 24, 36.*

DEAR SIR,

I have the pleasure to inform you of my arrival at this place on the 24th of July last just as the Rainy Season had set in therefore I could not make any excursions in the Country untill the end of Sept. then I left this place for the Hacienda of Calaguan [Calauan] in the center of

Luzon where I remained untill the 15th of this Month making excursions to the Woods and Mountains in the Neighborhood and I trust my Labours will meet your approbation having collected about 1150 species of all classes since my arrival and I am proud to say nearly 1/10 are Ferns of the most beautifull forms you can conceive. Two species are Trees and one a perfect shrub throwing its branches like the Fir, and all in Flower except two or three species. I have also many species of Mosses but not many Flowering Shrubs, like those of Chili in form. Many Trees give splendid Flowers but their time is principally in March, April and May, but many of them flower twice a year. I have collected upwards of 50 Species of Orchideae but not many in Flower and of the Fungi 125 Species.

I am now preparing for a Voyage to the Southern Islands viz. Zebu, Negros Leyte and Mindanao, and if I am not made a Prisoner by the Malays I trust I shall on my return in July next be able to give you as equally good an account of myself. As yet I have not made any excursions on the Sea Coast but yet I have collected 250 Species of Shells; Insects, Reptiles and Crustaceous subjects have had their due, and I have even surprised myself in what I have done.

My reception from the Govt. has been most flattering every facility has been offer'd and afforded and the Hospitality of the Resident Spaniards is far from my expectations although I experienced much of it in South America. During the time I was at Calaguan [Calauan] I well tried my Constitution amongst the Woods, Mountains, Marshes and Rivers some days out all the day in the rain. As yet I have not had a moment's pain except from Venomous Insects &c. which are abundant and what is more strange Calaguan [Calauan] is the most unhealthy spot in the Island therefore I trust the Climate will not injure my Health. Should anything happen to me that I should Die I have order'd all my Botanical Collection should be sent to your care and you to select out a perfect Collection with duplicates where necessary, for your own use and that you would be pleased to dispose of the remainder to those who would wish to take them on the former Terms *for the benefit of my Estate.* I should be most happy to hear from [you] particularly if I can be of any further service to you during my residence here.

I am Dear Sir

Yours Most Sincerely

[Signed] H. CUMING

To

Sir WILLIAM JACKSON HOOKER, Knt.

Regius Professor of Botany

Glasgow.

MANILA *Nov. 18, 1838.*

MY DEAR SIR,

I did myself the pleasure of writing you in Dec. 1836, and also in Nov. 1837, [? dated Nov. 10, 1836] and up to the present date I have not had an answer from you. I am fearfull the letters must have been lost, although all the others, I sent to England arrived, and have been acknowledg'd.

In my former letters I gave you some Idea of what I had been doing in this part of the World and my success in Collecting &c. I now will

give you a small Idea of my Voyages to the various provinces and Islands in this Government.

My first excursion was to the center part of Luzon, where I collected but a few things, from the state of Cultivation, &c.; the next, to the borders of the great lake where I collected about 200 species of plants, Ferns was the principal feature of the Trip. My next excursion to the Islands in the South as Panay, Guimaras, Negros, Siquijor, Zebu [Cebu], Bohol, Camiguing [Camiguin de Misamis] and Mindanao, which occupied 10 months and at the close the plants amounted to 1900 in all, in which were many Ferns. My last Trip has been a continuation of the Southern Islands, viz. Samar, Leyte, Masbate, Ticao, Burias, Mindoro and the South eastern Provinces of Luzon as Albay, Camarines, Tayabas and Batangas, here my Ferns have augmented vastly. I may say with propriety I have 400 species amongst which many Trees and one Shrub. In the Island of Samar I found a Rafflesia of which I have dried specimens and in spirits on the Roots of Trees, on which they grew, several species of Nepenthes, but few Flowers. Mosses, Lichens and Fucii are scarce, small annuals hardly any, shrubs but few, large Trees, and small ones, in abundance. The Vegetation is so luxurious the smaller plants cannot live, all open spaces are cover'd by high grass to 9 ft. high. My species now amount to 3000. The Ferns are magnificent of which I have ample sps. I have ascended several mountains to the very Top some 5, 6, and 7,000 Ft. high. On the Sea Coast nearly all the plants are the same in all localities; in the dark Woods and deep Glens is my delight. The Ill Health and fatigue that I have experienced has been very great, my Eyes are much injured by the sun; in short I am 10 years older than I ought to be. I am now preparing for the Northern part of the Island and expect to return in July next. In Oct. I leave this [place] for Singapore and that place in March 1840 for England of which I will advise you in time.

From the Govt. and all the Public authorities I am continually receiving proofs of their Friendship and protection and the Friars are my best Friends. My other Collections are equally rich, Shells, Birds, Insects &c. I have forwarded to the care of Mr. Brown a Trunk of a Tree Fern which I collected in the Crater of a Volcano; there were Thousands. I have but few small species some are so large that I have been compell'd to divide a leaf in four that has not a stem. In the North they are abundant in the Mountains. How I shall succeed I can't say as there is war betwixt the Negros and the White people and has been for some years. I must venture I cannot leave such a spot unsearch'd.

I have had the misfortune to have a large Case of plants stolen from the Warehouse in which it was deposited. I trust you will be able to procure for me several subscribers to take plants by the time I arrive in England, in the meantime

Believe me My dear Sir
Yours ever obliged most Sincerely
[Signed] H. CUMING.

Sir WILLIAM JACKSON HOOKER, KT.
L. L. D. F. R. S. &c.
Reg. Prof. Bot.
Glasgow.

8, KING'S ROAD GRAYS INN
LONDON *June 5th 1840*

MY DEAR SIR,

It is with pleasure I have to inform you of my safe arrival here this morning from Singapore with all my Collections I trust safe, and in as good a Condition as I am in Health.

Since I did myself the pleasure of writing you last, I have been at Mount Ophir in the Malayan Peninsula and have had the great pleasure of Collecting the splendid Fern [*Matonia pectinata* R. Br.] which I promised you to do before I left and many others from that Locality. It is not found at the Foot of the Mountain but 4600 feet high in great abundance, of which I have taken the liberty of Collecting a number of the finest specimens. Its roots creep along the Ground and each Frond stands from 5 to 7 Feet high.

If I have my Health, I expect to have all the plants in Order by the latter end of August and if it should meet your convenience to be in London at that or at a future period I shall be most happy to see you when a division is made of the Specimens more particularly so as it is my wish for you to have the first Choice in all the plants as before.

I shall feel most gratefull to you in procuring me subscribers for Collections of plants amongst your Friends. Perhaps some of them may object from the amount of a Collection being paid down at once. To make it convenient to them it can be paid in four Instalments, the first at the time of receiving them, and at 3, 6 and 9 months if it meets their pleasure.

My address at present is at 8 Kings Road, Grays Inn, London, in the meantime I will exert myself to get all the plants in Order, those Families that I am acquainted with I will put together such as the Ferns, Orchideae, Malvaceae, with their Localities, time collected &c.

If you have leisure I shall be most happy to hear from you.

I have 15 Species of Ferns from St. Helena which I collected one day there. I met a Clergyman who informed me that he intended to send you some plants from that Island. I think his name was Phelps. As all my Baggage is on board I cannot find his card to be certain of his Name.

I am Dear Sir
Yours most Sincerely
[Signed] H. CUMING

80 GOWER STREET, BEDFORD SQUARE
Aug. 1, 1840.

MY DEAR SIR,

I hasten to inform you that I have found Seven of my Cases of plants completely ruin'd by Water, the Tin Cases being eaten through and full of Holes. It must have occur'd in Manila, where the Cases where placed in a Store over which lived a Family who must have let water fall through the Floor and as there was not any Ceiling it did not leave any marks behind.

It must have been in '38 or '39 as all the Cases injured were collected in '36 - '37 and one in the early part of '38 and a few boxes of Shells of those Years have been also wet. Shells will not damage but little.

I have unpack'd one of the damaged Cases and I am happy to say all the Species of Ferns are but little injured and you will not lose a Species in this Case. Most all the other plants are gone. Where a specimen could be recognized I have kept it for your inspection.

I am fearful the above loss will reduce my numbers to near 2,000 Species. If so my loss will be great but it is not any use to repine. I know that your disappointment will be great even more than mine.

I am My Dr. Sir
Yours ever oblidg'd
[Signed] H. CUMING

80 GOWER STREET
BEDFORD SQUARE
Oct. 13, 1840

MY DEAR SIR,

I have the pleasure to inform you that my labours in unpacking are nearly finished, as I have but one case to set in order which I expect to be done by the end of the Week.

Mr. Brown was heard from a few days since and may be expected in Town before the end of the month is up. Soon as he arrives I shall request him to consult you respecting the selecting of the plants that your convenience may be studied as it respects the time.

I trust you have had influence with some of the principal Botanists to become subscribers for a selection of my plants. As I have experienced your Friendship in so many instances it makes me a little bold to ask another Favour in the above.

I have not written to Baron Fischer of St. Petersburg under a supposition that you might have communicated with him on the subject, neither have I address'd the Revd. Mr. Henslow[14] of Cambridge, as you did me the favour to get him to subscribe the last time.

A Mr. Shuttleworth[15] of Switzerland made a communication to the late Mr. Hunneman for a Collection but as I do not know that Gentlemans address I have not written to him. If you can give me any information respecting that Gentleman you will oblidge me much.

If you think it necessary I will advise Mr. Fielding the plants are nearly ready. I dont know if he intends to be present or not or if he has appointed any person to look out his specimens.

I am of an opinion that some of the Gentlemen will be annoy'd by the size of many of the Ferns, many of them are Magnificent and I could not find courage to cut them to pieces where my papers would admit their size. I am certain there is more then 400 species. The Matonia is superb and I have specimens of all the different stages for you.

I remain Dear Sir
Yours ever oblidg'd
Most Sincerely
[Signed] H. CUMING

To
Sir W. J. HOOKER, KT.

[14] J. S. Henslow, 1796–1861.—E. D. M.
[15] R. G. Shuttleworth, 1810–1874.—E. D. M.

80 GOWER STREET
BEDFORD SQUARE
London 11th Sep 1840

My dear Sir,

I have just received a letter from Mr. Fielding of Bolton Lodge who writes me that he has been informed by you that my plants has been affected by Insects, which I am most happy to contradict in the fullest Sence—not having seen any symptoms of Insects or Dust in the 15 cases I have already unpacked. Six of the cases has been injured by Rain Water they having been placed in a large store in Manilla during my absence in the provinces and the Rain came upon them during one of the Bagios [typhoon] and not been noticed the water saturated the wood and corroded the Tins but am happy to say that not a fern is lost.

I beg the favour that if this report is in circulation that you will be pleased to contradict it in the fullest sence as it may tend to do me a serious injury which I trust I do not deserve.

I expect to have the Plants ready from the 20th to the 25th of next month—when ready and I do not hear from you in the meantime will write you again.

I remn Dear Sir
Yours truly

H. CUMING

Sir WILLIAM JACKSON HOOKER, KNT.

18 THAVIES INN
Saturday morning

MY DEAR SIR,

It is with great pleasure I forward to you my *Child,* with all its imperfections bad grammar &c. &c. &c. for your perusal and to select those portions that are fit to meet the public Eye. I tremble at the thought of appearing before the public in the light of a Tourist or of one attempting to describe a New Country. Do speak of it as a light trifling thing as notes taken down in the wearied hours of a man suffering under disease and Fatigue whose only recommendation is Industry and perseverance under a Thousand disadvantages.

My Friends the Spaniards be most kind, for their unbounded Hospitality, kindness and universal desire to further my object in every instance where it could be rendered, from the highest to the most Indigent.

If any dark passage meets your eye note it and let me put it aright for I have not had time to read over what I have written, and the universal bad language which I have written will give you a most mean opinion of your Humble Friend.

Don't forget the Ferns I should say at least 400 Species, I think more. Orchideae also is worthy of Notice; of plants 3500 species; Shells 3210 do. of which there are 576 species and varieties, Fluviatale, Univales 118, and but few Bivalves from the Lakes and rivers.

I shall feel most obliged for a Manuscript Copy previous to its being sent to the press that I may be able to correct the Names of places and other matters, and let a few Copies be printed of seperate, to give my own private friends who feel a Brotherly interest in the labours of their relative.

I have yet many little things to write from where I left of which I will do in due time as to let you have it by the time I receive your abstract of my Journal.

Relying on your great Influence with the Botanists of this, and other Countries, I repose the dreaded Book into your Hands, and trust I shall be able to raise sufficient subscribers to take the major part of my specimens to repay my very great expences in procuring them, to those who may not desire to take a Collection from the Expence do me the favour to inform them I shall be most happy to receive One Quarter part of the amount at the time of receiving them, and the remainder at 3, 6 and 9 months in Bills, which I promise not to negociate in any manner whatever untill due.

The above, I have stated from a Conviction of your Friendship for me and the universal esteem and respect which you are held by all the world which gives you that gigantic influence over all the Botanists of the Civilized Globe which leads me to hope will be a sure means of procuring a ready sale of my dried specimens.

I have the Honour to be
Yours most devoted
ever gratefull
[Signed] H. CUMING

N. B.

When you have occasion to write me from Glasgow address at 80 Gower Street Bedford Square.

80 GOWER STREET
BEDFORD SQUARE
May 25th 1841

MY DEAR SIR,

I had the pleasure to receive your Note last evening, in answer to which I beg to say the plants have been pack'd up since the 15th of April and knowing that you was in Scotland I did not think you would like to have them sent to Kew untill your return to Town.

I trust the selection that I have made will give you that satisfaction I would wish, whenever I had a doubt as to usefullness of the specimen for examination I always referr'd to Mr. Bennett,[16] who was present all the time with one to two exceptions.

Since the selection I found two or three things put aside and forgotten untill too late to put them into the cases. I will pack them securely and cause them to be left where you will be pleased to order them.

On the other side I have given the Number of specimens &c. &c.

Now my dear Sir I must beg your kind indulgence for appearant trifling on my part respecting my Journal. I am most truly sorry that I should have given you so much trouble and then disappointment in this affair. I now candidly confess that I felt so much asham'd of the gross Ignorance of the English Language which I made in writing of the Journal and which I have not the ability to amend that I was compell'd to write you what I did and as you was justly hurt at my appearant trifling I

[16] J. J. Bennet, 1801–1875.—E. D. M.

had not the courage to answer your just rebuke at the time when you had so much to attend to and of so much importance, I can assure you I have been much hurt ever since I received your letter particularly as I have from the first day that I had the Honour to be known to you received the greatest attention and acts of kindness from your Hands. If I could have the pleasure of seeing you at any time convenient to yourself I trust I should be able yet make some amend for the appearant trifling conduct of mine, that kind of conduct I most devoutly detest, and to labour under that Character in your estimation grieves me much.

I remain My dear Sir
Yours ever oblidg'd

H. CUMING

Sir W. J. HOOKER

80 GOWER STREET
BEDFORD SQUARE
Novr. 26, 1841

DEAR SIR,

I had the pleasure to receive yours of the 23d yesterday and as it was not in my power to answer it untill I had seen Mr. Bennett of the Museum who has kept a correct List of all the Localities. Today on my visiting the Museum I found he was taking his Holidays I will write him should he be at St. Johns Wood to gain what you desire.

At the time the plants where selected the Localities where put on the Number which began with a New Locality and I am confident they were put on yours as it was done to every set. I saw many of them when I pack'd them in the Box. I shall feel a pleasure in procuring you any information you want respecting them.

[Signed] H. CUMING.

The list of localities mentioned in the last letter is very important and although it has already been published by me [17] it is here repeated to complete this record. Cuming apparently intended to sort his plants into natural groups before numbering the collection as a whole, but abandoned this plan after he had segregated the ferns and fern allies, cellular cryptogams, and three strongly marked groups of phanerogams, *Eugenia*, Loranthaceæ, and the Orchidaceæ. In this task he was assisted by Mr. J. J. Bennett of the Botanical Department of the British Museum.

He used a printed label "Ins. Philippinae 1841" for the entire collection although several hundred numbers were not collected in the Archipelago, but came from the Malay Peninsula, Singapore, Sumatra, and St. Helena. The localities were not written on all the labels as the sets of duplicates were prepared, but the new locality was added on the label of the first number from that locality. It was apparently expected that subscribers to

[17] Philip. Journ. Sci. 10 (1915) Bot. 183.

the sets would complete the labels, but this was rarely or never done. The result has been that many of Cuming's extra-Philippine plants occur in various herbaria under Philippine labels and have erroneously been credited to the Archipelago in botanical literature, in some cases involving genera that do not extend to the Philippines.[18] Cuming's own list of localities attached to his letter of November 26, 1841, is given below.

1– 434. Vascular Cryptogams, apparently distributed with properly prepared labels. Most of the species are from the Philippines, a few from Malacca, Singapore, etc.
435– 667. Calauang [Calauan], Province of Laguna, Luzon.
678– 694. Province of Tayabas, Luzon.
695– 702. Island of Corregidor [a small island at the entrance of Manila Bay].
703– 725. Province of Tondo [Rizal], Luzon.
726– 749. Provinces of Pampanga and Bulacan, Luzon.
750– 833. Province of Tayabas and the mountains of St. Cristobal and Maijaijai [that is, Mount Banajao, on the boundary between Laguna and Tayabas Provinces], Luzon.
834– 947. Province of Albay, Luzon.
948–1039. Province of Pangasinan, Luzon.
1040–1112. Not localized, but probably from the Province of Zambales, Luzon, judging from the species represented.
1113–1182. Province of South Ilocos [Ilocos Sur], Luzon.
1183–1260. Province of North Ilocos [Ilocos Norte], Luzon.
1261–1380. Province of Cagayan, Luzon.
1381–1454. Province of Nueva Ecija, Luzon.
1455–1478. Province of South Camarines [Camarines Sur], Luzon.
1479–1603. Island of Mindoro.
1604–1673. Province of Misamis, Mindanao.
1674–1732. Island of Samar.
1733–1757. Island of Leyte.
1758–1789. Island of Cebu.
1790–1810. Island of Negros.
1811–1857. Island of Bohol.
1858–2153[18] Philippine material, not localized (exceptions 2052; 2053–2058).
2052. Malacca.
2053–2058. Singapore.
2252–2399. Malacca.
2400–2427. Singapore.
2428–2443. Sumatra.
2444–2464. St. Helena.

It is manifest that Cuming did not collect botanical material on all the islands he visited, for the published record shows

[18] See Vidal, Rev. Pl. Vasc. Filip. (1885) 83: "2154–2242 Criptogamas celulares." These were chiefly from the Philippines.

that he secured shells from Capul, Tablas, Temple, Guimaras, Burias, Camiguin de Misamis, Lubang, Siquijor, Bantayan, and Cuyo, islands that are not mentioned by him as localities in which he collected botanical material. Many of these islands are rather small, and most, but not all of them, are uninteresting from a botanical standpoint.

PARTIAL BIBLIOGRAPHY

This partial bibliography includes only papers based wholly or in large part on Philippine material collected by Hugh Cuming. Very many of them were originally printed in the Proceedings of the Zoölogical Society, London, here abbreviated as P. Z. S., and those there published were for the most part reprinted without change in form or title in the Annals and Magazine of Natural History, here abbreviated as A. M. N. H. These reprinted papers in the Annals and Magazine of Natural History sometimes appeared during the same year in which they were originally published in the Proceedings of the Zoölogical Society, sometimes the year following, and in some cases two years after they were originally printed. The original place of publication of all species considered in these two serials is in the Proceedings of the Zoölogical Society.

ADAMS, A.

On the animal of Liotia; with a description of new species of Delphinula and Liotia, from the Cumingian collection. P. Z. S. 18 (1850) 50–52, *t. 8;* A. M. N. H. II 7 (1851) 332–335.

Monograph of Sphaenia, a genus of lamellibranchiate Mollusca. P. Z. S. 18 (1850) 86–89; A. M. N. H. II 7 (1851) 420–421.

A monograph of Scarabus, a genus of air-breathing gasteropodous Mollusca from specimens in the Cumingian collection. P. Z. S. 18 (1850) 147–152; A. M. N. H. II 8 (1851) 66–70.

A catalogue of the species of Emarginula, a genus of gasteropodous Mollusca, belonging to the family Fissurellidae, in the collection of H. Cuming, Esq. P. Z. S. 19 (1851) 82–92; A. M. N. H. II 11 (1853) 146–153.

Catalogue of the species of Nassa, a genus of gasteropodous Mollusca belonging to the family Buccinidae, in the collection of Hugh Cuming, Esq., with the descriptions of some new species. P. Z. S. 19 (1851) 94–114; A. M. N. H. II 11 (1853) 320–325, 410–418.

Descriptions of fifty-two new species of the genus Mitra, from the Cumingian collection. P. Z. S. 19 (1851) 132–141; A. M. N. H. II 12 (1853) 48–58.

Contributions towards a monograph of the Trochidae, a family of gasteropodous Mollusca. P. Z. S. 19 (1851) 150–192; A. M. N. H. II 12 (1853) 142–148, 199–213.

A monograph of the genus Monoptygma of Lea. P. Z. S. 19 (1851) 222–224; A. M. N. H. II 12 (1853) 281–283.

ADAMS, A.—Continued.

A monograph of the recent species of Rimula, a genus of Mollusca, belonging to the family Fissurellidae. P. Z. S. **19** (1851) 226–227; A. M. N. H. II **12** (1853) 284–285.

Descriptions of sixteen new species of Rissoina, a genus of marine gasteropodous mollusks, from the Cumingian collection. P. Z. S. **19** (1851) 264–267; A. M. N. H. II **13** (1854) 65–68.

Descriptions of several new species of Murex, Rissoina, Planaxis, and Eulima, from the Cumingian collection. P. Z. S. **19** (1851) 267–272; A. M. N. H. II **13** (1854) 152–156.

Descriptions of new species of Eulima, Triphorus, etc., from the collection of Hugh Cuming, Esq. P. Z. S. **19** (1851) 276–277.

BENTHAM, G.

Botanical memoranda: The Memecyla of Cuming's collections. Journ. Linn. Soc. Bot. **5** (1861) 77–78.

BERKELEY, M. J.

Enumeration of the fungi collected by H. Cuming Esq., F. L. S., in the Philippine Islands. Lond. Journ. Bot. **1** (1842) 142–157, *t. 6–7.*

BRODERIP, W. J.

Descriptions of species of Bulinus collected by H. Cuming, Esq. P. Z. S. **9** (1841) 14–16; A. M. N. H. **8** (1842) 380–382.

Descriptions of shells collected by H. Cuming, Esq., in the Philippine Islands. P. Z. S. **8** (1840) 83–87, 94–96, 119–125, 155–159, 180–182; **9** (1841) 22–23, 34–39, 44–46; **10** (1842) 53–55; A. M. N. H. **7** (1841) 226–229, 335–337, 546–551; **8** (1842) 62–66, 148–150, 380–382, 466–467, 527–531.

CARPENTER, P. P.

Description of new species and varieties of Calyptreidae, Trochidae, and Pyramidellidae, principally in the collection of Hugh Cuming, Esq. P. Z. S. **26** (1856) 166–171.

DESHAYES, G. P.

Descriptions of new species of shells in the collection of Mr. Cuming. P. Z. S. **21** (1853) 1–11; **22** (1854) 13–23, 62–72, 317–371.

Sur le genre Galeomma, Turtõn. P. Z. S. **23** (1855) 167–171.

Sur le genre Scintilla. P. Z. S. **23** (1855) 171–181.

Descriptions de nouvelles espéces du genre Erycina. P. Z. S. **23** (1855) 181–183.

DILLWYN, L.

On an undescribed species of Megapodius. P. Z. S. **19** (1851) 118–119, *t. 39;* A. M. N. H. II **11** (1853) 469–471.

DUNKER, G.

Myrtilacea nova collectionis Cumingianae. P. Z. S. **26** (1856) 358–366.

FRASER, L.

Description of two new species of birds from Luzon. P. Z. S. **7** (1839) 112–113; A. M. N. H. **5** (1840) 60–61.

GASKOIN, J. S.

On new species of Cypraea. P. Z. S. **11** (1843) 23–25; A. M. N. H. **13** (1844) 71–73.

Description of new species of the genus Cypraea. P. Z. S. **16** (1848) 90–98.

HANLEY, S.
Descriptions of new species of Mytilacea, Amphidesma, and Odostomia. P. Z. S. 12 (1844) 14–18; A. M. N. H. 14 (1844) 367–370.
Descriptions of new species of Tellina, collected by H. Cuming, Esq. P. Z. S. 12 (1844) 59–64, 68–72, 140–144, 146–149, 164–166; A. M. N. H. 14 (1844) 504–509; 15 (1845) 46–50, 363–371, 435–437.
Descriptions of new species of Cytherea. P. Z. S. 12 (1844) 109–110.
Descriptions of new species of Cyrena, Venus, and Amphidesma. P. Z. S. 12 (1844) 159–162; A. M. N. H. 15 (1845) 431–435.
Descriptions of new species of Ostrea, in the collection of Hugh Cuming, Esq. P. Z. S. 13 (1845) 105–107; A. M. N. H. 17 (1846) 288–290.

HASSKARL, J. K.
Ueber einige neue Pflanzen der Philippinen aus der Cuming'schen Sammlung. Flora 48 (1865) 401–403.

HINDS, H. B.
On two new species of Triphoris, in the collection of H. Cuming, Esq. P. Z. S. 11 (1843) 22–23; A. M. N. H. 12 (1843) 449.
Descriptions of shells collected during the voyage of H. M. S. Sulphur, and by H. Cuming, Esq. P. Z. S. 12 (1844) 72–77, 96–98; A. M. N. H. 14 (1844) 436–446.

JONAS, J. H.
Descriptions of new species of shells belonging to the genera Helix and Bulinus, collected by Mr. Cuming in the Philippine Islands. P. Z. S. 10 (1842) 188–189; A. M. N. H. 12 (1843) 365–366.

LEA, J.
Description of five new species of Anodontae collected by H. Cuming, Esq., in the East Indies. P. Z. S. 18 (1850) 197–199; A. M. N. H. II 8 (1851) 493–496.

LEA, J., and H. C.
Description of a new genus of the family Melaniana, and of many new species of the genus Melania, chiefly collected by Hugh Cuming, Esq., during his zoölogical voyage in the East, and now first described. P. Z. S. 18 (1850) 179–197; A. M. N. H. II 9 (1852) 58–70, 142–148.

MARTIN, W.
On two specimens of saurian reptiles sent to the society by Mr. Cuming. P. Z. S. 6 (1838) 68–70; A. M. N. H. 3 (1839) 68–70.

MERRILL, E. D.
Notes on Cuming's Philippine plants in the herbarium of the Bureau of Government Laboratories. Govt. Lab. Publ. (Philip.) 35 (1905) 69–77.

MONTAGNE, C.
Plantas cellulares quas in insulis Philippensibus a cl. Cuming collectas recensuit observationibus non nullis descriptionibus illustravit. Hook. Lond. Journ. Bot. 3 (1844) 658–662; 4 (1845) 3–11.

NEES AB ESENBECK, C. G.
Gramineae herbarii Lindleyani. Hook. Journ. Bot. Kew Miscel. 2 (1850) 97–105.
Cyperaceae Cumingianae (Insularum Philippinensium) herbarii Lindleyani. Hook. Journ. Bot. Kew Miscel. 6 (1854) 27–30.

PALACKY, J.
Uebersicht der von Miquel in der Flora Indiae batavae bestimmten Cuming'schen Philippinen-Pflanzen. Flora 43 (1860) 446–448.

PFEIFFER, L.
Descriptions of new species of shells, belonging to the genera Helix and Bulinus, collected by H. Cuming, Esq., in the Philippine Islands. P. Z. S. 10 (1842) 84–89; A. M. N. H. 11 (1843) 471–475.
Descriptions of new species of shells, collected by H. Cuming, Esq., in the Philippine Islands. P. Z. S. 10 (1842) 150–153; A. M. N. H. 12 (1843) 138–141.
Descriptions of new species of Helix and a new Glandina, in the collection of Hugh Cuming, Esq. P. Z. S. 13 (1845) 38–42; A. M. N. H. 16 (1845) 253–257.
Descriptions of new species of land-shells from the collection of Hugh Cuming, Esq. P. Z. S. 13 (1845) 43–61; A. M. N. H. 16 (1845) 332–335.
Descriptions of twenty-two new species of land-shells in the collection of Hugh Cuming, Esq. P. Z. S. 13 (1845) 63–68; A. M. N. H. 16 (1845) 336–341.
Description of a new species of Amphipeplea. P. Z. S. 13 (1845) 68; A. M. N. H. 16 (1845) 341.
Descriptions of twenty-two new species of Helix. P. Z. S. 13 (1845) 71–75; A. M. N. H. 16 (1845) 341–346.
Descriptions of fourteen new species of Helix from the collection of Hugh Cuming, Esq. P. Z. S. 13 (1845) 123–125; A. M. N. H. 17 (1846) 431–434.
Descriptions of thirty-six new species of Helix from the collection of Hugh Cuming, Esq. P. Z. S. 13 (1845) 126–133; A. M. N. H. 17 (1846) 434–441.
Descriptions of thirty new species of Helicea, belonging to the collection of Hugh Cuming, Esq. P. Z. S. 14 (1846) 28–34; A. M. N. H. 18 (1846) 58–64.
Descriptions of twenty new species of Helicea, in the collection of Hugh Cuming, Esq. P. Z. S. 14 (1846) 37–41; A. M. N. H. 18 (1846) 123–127.
Descriptions of nine new species of Helicea, collected by Hugh Cuming. P. Z. S. 14 (1846) 41–43; A. M. N. H. 18 (1846) 127–129.
Descriptions of twenty-three new species of Vitrina from the collection of H. Cuming, Esq. P. Z. S. 16 (1848) 104–109.
Descriptions of fourteen new species of Helicina from the collection of H. Cuming, Esq. P. Z. S. 16 (1848) 109–112.
Descriptions of twenty-three new species of land shells, from the collection of H. Cuming, Esq. P. Z. S. 21 (1853) 48–54.

PHILIPPI, R. A.
Descriptions of new species of Trochus, and of eighteen new species of Littorina, in the collection of Hugh Cuming, Esq. P. Z. S. 13 (1843) 138–143; A. M. N. H. 17 (1846) 443–447.

RECLUZ, C. A.
Descriptions of various species of Navicella, collected by Hugh Cuming, Esq., in the Philippine Islands. P. Z. S. 10 (1842) 154–160; A. M. N. H. 12 (1843) 141–147.

RECLUZ, C. A.—Continued.

Descriptions of new species of Nerites, collected by H. Cuming, Esq., in the Philippine Islands. P. Z. S. 10 (1842) 168–176; A. M. N. H. 12 (1843) 276–284.

On new species of Narica. P. Z. S. 11 (1843) 136–141; A. M. N. H. 14 (1844) 57–59.

Descriptions of new species of Navicella, Neritina, Nerita, and Natica, in the collection of Hugh Cuming, Esq. P. Z. S. 11 (1843) 197–214; A. M. N. H. 14 (1844) 130–145.

Déscription de quelques nouvelles Nérites fluviatiles du cabinet de H. Cuming, Esq. P. Z. S. 13 (1845) 119–122; A. M. N. H. 17 (1846) 292–293.

Description d'une nouvelle espéce de Conovulus. P. Z. S. 13 (1845) 122; A. M. N. H. 17 (1845) 295.

REEVE, L.

Description of a new species of Corbis, a genus of acephalous molluscs of the family Nymphacea. P. Z. S. 9 (1841) 85–96; A. M. N. H. 9 (1840) 501.

Characters of a new species of Nitra, a genus of pectinibranchiate molluscs of the family Columellata. P. Z. S. 9 (1841) 93; A. M. N. H. 10 (1842) 509.

Descriptions of new species of shells, principally from the collection of Hugh Cuming, Esq. P. Z. S. 10 (1842) 49–50; A. M. N. H. 11 (1843) 308–309.

Descriptions of new species of Delphinula, a genus of pectinibranchiate molluscs of the family Turbinacea. P. Z. S. 10 (1842) 102–104; A. M. N. H. 11 (1843) 521–523.

Descriptions of new species of shells belonging to the genera Trochus and Turbo. P. Z. S. 10 (1842) 184–186; A. M. N. H. 12 (1843) 286–288.

Descriptions of four new species of Conus. P. Z. S. 11 (1843) 12–13; A. M. N. H. 12 (1843) 449.

A new species of Delphinula. P. Z. S. 11 (1843) 141–143; A. M. N. H. 13 (1844) 515–517.

On new species of Conus, Pleurotoma, Pectunculus, Cardita, and Cypricardia. P. Z. S. 11 (1843) 168–196; A. M. N. H. 14 (1844) 297–309.

Descriptions of seven new species of Glauconome. P. Z. S. 12 (1844) 19–21; A. M. N. H. 14 (1844) 372–373.

Descriptions of thirty-three new species of Arca. P. Z. S. 12 (1844) 39–48; A. M. N. H. 14 (1844) 486–495.

Monograph of the genus Myadora. P. Z. S. 12 (1844) 91–94; A. M. N. H. 15 (1845) 61–64.

Descriptions of new species of Triton, collected chiefly by Hugh Cuming, Esq. P. Z. S. 12 (1844) 110–122; A. M. N. H. 15 (1845) 199–210.

Descriptions of new species of Arca, from the cabinet of Hugh Cuming, Esq. P. Z. S. 12 (1844) 123–128; A. M. N. H. 15 (1845) 355–359.

Descriptions of new species of Ranella. P. Z. S. 12 (1844) 136–140; A. M. N. H. 15 (1845) 360–363.

REEVE, L.—Continued.

Descriptions of new species of Nitra and Cardium. P. Z. S. 12 (1844) 167–187; A. M. N. H. 15 (1845) 475–495.

Descriptions of eighty-nine new species of Mitra, chiefly from the collections of Hugh Cuming, Esq. P. Z. S. 13 1843) 45–61; A. M. N. H. 16 (1845) 257–273.

Descriptions of new species of Murex. P. Z. S. 13 (1845) 85–88; A. M. N. H. 17 (1846) 129–132.

On new species of Pleurotoma. P. Z. S. 14 (1846) 3–6; A. M. N. H. 17 (1846) 478–481.

Descriptions of fifty-four new species of Mangelia from the collections of Hugh Cuming, Esq. P. Z. S. 14 (1846) 59–65; A. M. N. H. 18 (1846) 202–208.

Descriptions of new species of Chama. P. Z. S. 14 (1846) 117–120; A. M. N. H. 19 (1847) 270–273.

ROLFE, R. A.

The localities of Cuming's Philippine plants. Kew Bull. (1908) 116–119.

SAUSSAYE, P. DE LA.

Descriptions of new species of shells belonging to the genus Auricula, collected by H. Cuming, Esq. P. Z. S. 10 (1842) 201–202; A. M. N. H. 12 (1843) 437–438.

Descriptions of Elasmatina and Scarabus in the collection of H. Cuming, Esq. P. Z. S. 11 (1843) 2–3; A. M. N. H. 12 (1843) 439–440.

SMITH, J.

Enumeratio Filicum Philippinarum; or a systematic arrangement of the ferns collected by H. Cuming, Esq. F. L. S., in the Philippine Islands and the Peninsula of Malacca, between the years 1836 and 1840. Hook. Journ. Bot. 3 (1841) 392–422.

SOWERBY, G. B.

Descriptions of shells collected by H. Cuming, Esq., in the Philippine Islands. P. Z. S. 8 (1840) 87–91, 96–104, 116–118, 135–137, 167–169; A. M. N. H. 7 (1841) 230–234, 337–344, 543–545, 560–561; 8 (1842) 72–74.

On some new species of the genus Cardium chiefly from the collection of H. Cuming, Esq. P. Z. S. 8 (1840) 105–111; A. M. N. H. 7 (1841) 506–511.

Descriptions of some new species of Murex, principally from the collection of H. Cuming, Esq. P. Z. S. 8 (1840) 137–147; A. M. N. H. 7 (1841) 562–571.

Descriptions of new species of shells collected by H. Cuming, Esq., in the Philippine Islands. P. Z. S. 9 (1841) 1–3, 17–20, 24–26, 39–40; A. M. N. H. 8 (1842) 383–387, 467–470, 531–533.

Descriptions of eight new species of the genus Ranella. P. Z. S. 9 (1841) 51–53; A. M. N. H. 8 (1842) 538–540.

Descriptions of several new species of Chitones brought by H. Cuming, Esq., from the Philippine Islands. P. Z. S. 9 (1841) 61–62; A. M. N. H. 9 (1842) 60–61.

Descriptions of nine species of the genus Pupina. P. Z. S. 9 (1841) 101–103; A. M. N. H. 10 (1842) 213–217.

SOWERBY, G. B.—Continued.

Descriptions of four species of the genus Chiton, brought by H. Cuming, Esq., from the Philippine Islands. P. Z. S. 9 (1841) 104; A. M. N. H. 10 (1842) 216–217.

Descriptions of some new species of Helicinae, in the collection of H. Cuming, Esq. P. Z. S. 10 (1842) 6–8; A. M. N. H. 10 (1842) 400–402.

Descriptions of new species of shells belonging to the genus Cyclostoma, collected by H. Cuming, Esq., in the Philippine Islands. P. Z. S. 10 (1842) 80–94; A. M. N. H. 11 (1843) 466–471.

Descriptions of two new species of shells belonging to the genus Strombus, collected by H. Cuming, Esq. P. Z. S. 10 (1842) 193–194; A. M. N. H. 12 (1843) 132–133.

Descriptions of new species of Lima. P. Z. S. 11 (1843) 23; A. M. N. H. 13 (1844) 71.

On new species of Cyclostoma in the collection of H. Cuming, Esq. P. Z. S. 11 (1843) 29–31; A. M. N. H. 13 (1844) 130–132.

Descriptions of new species of Scalaria collected by Hugh Cuming, Esq. P. Z. S. 12 (1844) 10–14, 26–31; A. M. N. H. 14 (1844) 364–367.

Descriptions of new species of Columbella, from the collection of Hugh Cuming, Esq. P. Z. S. 12 (1844) 48–53; A. M. N. H. 14 (1844) 495–501.

Descriptions of some new species of Ovulum in the collection of Mr. Cuming. P. Z. S. 16 (1848) 135–136.

Descriptions of some new species of Cancellaria in the collection of Mr. H. Cuming. P. Z. S. 16 (1848) 136–138.

On a new genus of Pholadidae, with notices of several new species and of a remarkable specimen of Pholas calva in Mr. Cuming's collection. P. Z. S. 17 (1849) 160–162, *t. 5.*; A. M. N. H. II 6 (1850) 299–302.

TURCZANINOW, N.

Description des Elaeocarpées des collections asiatiques de MM. Cuming et Zollinger. Bull. Soc. Nat. Mosc. 19^2 (1846) 488–496.

Decas secunda generum adhunc non descriptorum adjectis descriptionibus nonnullarum specierum Byttneriacearum. Bull. Soc. Nat. Mosc. 19^2 (1846) 497–510.

Decas tertia generum adjuc non descriptorum adjectis descriptionibus nonnullarum specierum Myrtacearum Xerocarpicarum atque Umbelliferarum imperfectarum. Bull. Soc. Nat. Mosc. 20^1 (1847) 148–174.

Asclepiadeae aliquae indescriptae. Bull. Soc. Nat. Mosc. 21^1 (1848) 250–262.

Decas quarta et quinta generum adjuc non descriptorum. Bull. Soc. Nat. Mosc. 21^1 (1848) 570–591.

Synanthereae quaedam hucusque indescriptae. Bull. Soc. Nat. Mosc. 24^1 (1851) 166–214.

Asclepiadaceae quaedam indescriptae fasciculus 2. Bull. Soc. Nat. Mosc. 25^2 (1852) 310–325. Reprinted in Flora (1853) 719–725.

TURCZANINOW, N.—Continued.

Animadversiones ad primam partem herbarii Turczaninowianii nunc Universitatis Caesareae Charkowiensis. Bull. Soc. Nat. Mosc. **27** [2] (1854) 271 bis 372.

Animadversiones in secundam partem herbarii Turczaninowianii, nunc Universitatis Caesareae Charkowiensis. Bull. Soc. Nat. Mosc. **31** [1] (1858) 185–250, 379–476.

Verbenaceae et Myporaceae nonnullae hucusque indescriptae. Bull. Soc. Nat. Mosc. **36** [2] (1863) 193–227.

Quelques observations sur les espéces du genre Clethra. Bull. Soc. Nat. Mosc. **36** [2] (1863) 228–235.

Animadversiones ad Catalogum primum et Secundum herbarii Universitatis Charkowiensis. Bull. Soc. Nat. Mosc. **36** [1] (1863) 545–615.

VIDAL y SOLER, S.

Phanerogamae Cumingianae Philippinarum, ó Indice numérico sistemático de las plantas fanerogamas coleccionado en Filipinas por Hugh Cuming, con características de algunas especies no descritas y del género Cumingia (Malvaceas) (1885) XV 1–217, *t. 1.*

WATERHOUSE, G. R.

On a new species of rodent from the Island of Luzon (Phloeomys cumingi). P. Z. S. **7** (1839) 107–108; A. M. N. H. **5** (1840) 57–58.

Description of a new species of squirrel (Sciurus philippinensis) from the Philippine Islands. P. Z. S. **7** (1839) 117–118; A. M. N. H. **5** (1840) 63–64.

Descriptions of the species of the curculionideous genus Pachyrrhynchus Sch., collected by H. Cuming, Esq., in the Philippine Islands. A. M. N. H. **8** (1841) 218–220; Trans. Entomol. Soc. London **3** (1843) 310–327.

Descriptions of various coleopterous insects brought from the Philippine Islands by Mr. Cuming. A. M. N. H. **8** (1841) 221–222.

Descriptions of new species of coleopterous insects belonging to the genus Apocyrtus, collected by Hugh Cuming, Esq., in the Philippine Islands. A. M. N. H. **9** (1842) 302–311; **11** (1843) 247–255.

Descriptions of some new longicorn and rhynchophorous beetles from the Philippine Islands. A. M. N. H. **10** (1842) 70.

Descriptions of two new species of the genus Mus. P. Z. S. **10** (1842) 145–146; A. M. N. H. **12** (1843) 131–135.

On various species of bats collected by H. Cuming, Esq., in the Philippine Islands. P. Z. S. **11** (1843) 66–68; A. M. N. H. **13** (1844) 302–304.

On a new species of Megaderma. P. Z. S. **11** (1843) 69; A. M. N. H. **13** (1844) 304.

On new species of bats collected in the Philippine Islands and presented to the society by Hugh Cuming, Esq. P. Z. S. **13** (1845) 3–10; A. M. N. H. **16** (1845) 49–56.

Descriptions of some new coleopterous insects from the Philippine Islands, collected by H. Cuming, Esq. Trans. Entomol. Soc. London **4** (1845) 36–45.

WESTWOOD, J. O.

Description of an Asiatic genus of lamellicorn beetles belonging to the family Rutelidae. Trans. Entomol. Soc. London **4** (1845) 91–99.

WHITE, A.
Descriptions of new Crustacea from the eastern seas. P. Z. S. 14 (1846) 56–61; A. M. N. H. 20 (1847) 61–63.
Descriptions of some new species of Crustacea in the collections of the British Museum. P. Z. S. 14 (1846) 84–86; A. M. N. H. 20 (1847) 205–208.
Short descriptions of new or little known decapod Crustacea. P. Z. S. 14 (1846) 222–228.

ILLUSTRATION

PLATE 1. Hugh Cuming, 1791–1865.

PLATE 1. HUGH CUMING, 1791–1865.

ORIGIN, DEVELOPMENT, AND NATURE OF THE STONY LAYER OF THE COCONUT (COCOS NUCIFERA LINNÆUS) [1]

By JOSÉ B. JULIANO [2]

Of the College of Agriculture, Los Baños, Laguna

THREE PLATES

INTRODUCTION

Most of the researches on the coconut have been purely physiological, chemical, or agronomical; morphologically, very little has been done. This paper has for its main purpose the report of a critical study of the origin, development, and nature of the stony layer, or shell, of the coconut (*Cocos nucifera* Linnæus) and the surrounding tissues. The report includes an account of the development of the spadix, the female flower, and the fruit. The reader is referred to the work of Quisumbing(10) for a description of the development of the stony layer in the most important groups of gymnosperms and in a few of the angiosperms.

The literature dealing with the inflorescence and the female flower consists mostly of taxonomic descriptions; apparently the ontogeny has not been studied.

Taxonomists in general regard the fruit of the coco as a drupe consisting of a smooth, tough, brownish to grayish epicarp; a fibrous, mottled brown mesocarp; and a hard, thick, brown endocarp within which is the endosperm inclosed in a closely adhering testa. Very few botanists have attempted to describe the parts of the fruit anatomically. Winton(13) is the only investigator who has given a detailed histological description of the tissues of the mature nut. Wiesner(12) made microscopical examinations of the individual cells constituting the shell and found that the ground tissue was sclerenchymatous, with

[1] Thesis presented for graduation for the degree of Master of Science in Botany, University of the Philippines, No. 222, Experiment Station contribution No. 356.

[2] Read before the Los Baños Biological Club, December 11, 1924.

cells of different shapes. He conducted microchemical tests of the outer and inner *Samenhaut* and found that the cell walls of the outer turned red with phloroglucin-hydrochloric acid and the inner exhibited a negative reaction. Winton,(13) describing the individual cells, states that they possess thick, deep yellow walls with branching pores and dark brown contents. They are either isodiametric or strongly elongated, being usually spindle- or wedge-shaped; but hooked and various other curious forms also occur.

MATERIAL AND METHODS

The material used in this study was gathered on July 16, 1923, from six apparently healthy and vigorously growing trees in the Bacomo Coconut Plantation of the College of Agriculture, University of the Philippines. The method of attack was from the large mature nuts to the last spadix of the trees. As a result two of the trees were killed and all visible spadices were fixed. Slabs were sliced from the four sides of the younger pistils with their floral envelopes, and the remainder fixed in toto. Ovaries of intermediate age and older were cut into blocks of about 1 cubic centimeter, selected from the chalazal, middle, and micropylar regions, and then fixed.

Several fixing agents were tried, but formo-alcohol (Chicago formula) (3) and formo-aceto-alcohol were most satisfactory. A 1 per cent chromo-acetic fixative was found to preserve the material well, but made cutting difficult. Hot corrosive sublimate reagent was also tried; fixation was rapid, but this reagent caused the material to shrink and the cell walls to collapse.

After fixing, the material was washed as usual, dehydrated by passing through successive grades of alcohol, de-alcoholized in several ascending series of xylols, embedded in paraffin, and cut with a Spencer rotary microtome into sections of 7 to 10 microns in thickness. In the case of the mature stony layer, the material was first cut into small pieces of 0.5 by 3 centimeters, and then boiled for some time in water. The pieces were allowed to cool and were then transferred to hydrofluoric acid of full strength. After forty-two days they were washed in running water and cut with the aid of the Bausch and Lomb sliding microtome. Softer ones were cut without immersing them in hydrofluoric acid.

Several stains were tried. Flemming's triple stain and Haidenhain's iron-alum hæmatoxylin with orange gold, dissolved in clove oil as background, proved to be satisfactory.

THE INFLORESCENCE

The inflorescence of the coco palm, surrounded and inclosed by large, tough sheathing bracts called spathes, arises at the axil of the petiole. The whole flower cluster (Plate 1, fig. 1) consists of a central axis, the rachis, from which the rachillæ (Plate 1, fig. 2) arise in spiral succession. At their apices the rachillæ bear male flowers in the axils of the tertiary bracts, singly or in pairs, and female flowers at their bases. Teratological cases have been reported by Andy,(1) Burkill,(2) Furtado,(5) Parthasarathy Iyengar,(8) Petch,(9) and Smith,(11) in which "bulbiliferous coconut with deciduous and sterile inflorescence develops leaves instead of flowers."

The inflorescence initial begins as a minute protuberance at the axil of the clasping petiole (Plate 1, fig. 3). Arising at the basal portion of the inflorescence initial are two primary clasping bracts (Plate 1, figs. 3 and 4), one of which is situated toward the "cabbage," and the other between the petiole and the inflorescence initial. The first primary bract (Plate 1, fig. 5) envelops the second primary bract. Both of these bracts outgrow the whole floral cluster, thus forming two envelopes, the outer and the inner spathes, surrounding the actively growing inflorescence. The apex of this meristematic tissue of the inflorescence initial when 240 microns in length and 270 microns in width (Plate 1, figs. 3 and 4) shows signs of the formation of the primary inner bract which later develops into a persistent inflorescence envelope. After the spathes have formed complete envelopes to the growing point of the inflorescence, the cone gives rise to lateral protuberances which later develop into the secondary bracts (Plate 1, fig. 5). The lower secondary bracts tend to elongate more rapidly than do those at the apex so that their tips (Plate 1, figs. 6 and 7) are nearly as long as the apex of the main axis of the whole inflorescence. Concomitant with the production of secondary bracts by the main axis, and following them in succession, primordia of the rachillæ (Plate 1, fig. 8) make their appearance at the axils of the basal secondary bracts. They elongate vertically and parallel to the main axis of the inflorescence (Plate 1, fig. 9), leaving the secondary bracts behind. These axillary lateral primordia of the main axis of the inflorescence develop as secondary axes, rachillæ, which occur in spiral succession throughout the whole length of the main axis. The rachis almost always terminates with a single rachilla similar to its lateral branches. The rachillæ in turn give rise to lateral outgrowths, or tertiary bracts, which serve

as temporary floral envelopes (Plate 1, figs. 10 and 11). At the axils of the tertiary bracts, the flowers develop. All the bracts, primary, secondary, and tertiary, are persistent, even in the mature, dried specimens. The secondary and tertiary bracts never attain great size.

THE FEMALE FLOWER

The female flowers arise at the axils of the tertiary bracts, which are tiny, collarlike structures at the very basal portion of the flowers and are hardly distinguishable after the maturity of the pistils. The female flowers can be distinguished from the male flowers by their size and shape; both male and female flowers are developed on the same rachilla. In some varieties of coco palm, especially those with pink pistils when young, the female flowers can be easily distinguished from the male flowers in the cluster by their color and size. The female flowers are pinkish and the male flowers outnumber them; the former are somewhat spherical, whereas the latter are triangular (Plate 1, fig. 1). The younger and smaller the inflorescence the less marked the difference between the female and the male flowers. On nearly every rachilla one, two, three (Plate 2, fig. 1), or five (in rare cases as many as nine) female flowers develop. The peripheral rachillæ nearly always bear male flowers. Subtending each female flower are eight floral envelopes, as reported by Furtado(4) and Möbius.(7) However, taxonomists consider the female flower to possess only six floral envelopes, three sepals, and three petals. The first two and outer floral envelopes are small and have a scaly appearance, from which the name *Schuppenblätter* was derived. These were called bracteoles, or prophylls, by Furtado;(4) they are rendered inconspicuous by the developing fruit, later losing their identity as floral envelopes. Within these two scaly leaves (bracteoles) are three sepals which envelop the whole pistil. The outermost and largest of the three sepals nearly covers the whole flower, its apex reaching the tip of the pistil. They are characterized by their prolific production of cells containing raphides. The petals, three in number, are located within these sepals and are much thinner and paler. Subtending the ovary at its base is a thin yellowish ring, the aril. Within the appressed covering of floral envelopes is the more or less spherical pistil with sessile stigmas. Before and just after the opening of the inner spathe, the pistil is inclosed by the floral envelopes and it emerges only after two or three weeks. The ovary is tricarpous (Plate 2, fig. 3), and each carpel possesses an ovule (Plate 2, figs. 3 and 4). One ovule

usually functions, and the other two either abort or degenerate. Cases of two or three functional ovules are rare.

The individual female flower starts its ontogenetic development as an emergence in the axil of the tertiary bract of the rachilla. Two or three floral primordia may arise simultaneously from the axil of a tertiary bract. If only a female flower is developed, the male flowers around it may degenerate (Plate 2, fig. 1). Nearly all the cells of the undifferentiated outgrowths are isodiametric. The mode of development of the floral organs is centripetal (Plate 2, figs. 5 to 8). At the axil of the tertiary bract and the floral cone, two scale leaves appear as two small papillate protrusions which elongate, bend, and cover the juvenile flower (Plate 2, fig. 5). As soon as these bracteoles have developed, the three sepals develop simultaneously from the basal portion of the flower primordium, one overlapping the others toward the apex (Plate 2, fig. 6). The sepals also elongate, pushing their way between the bracteoles and the floral cone. The petals which alternate with the sepals next emerge simultaneously (Plate 2, figs. 6 and 7), first as rudimentary papillæ, but soon differentiate into scalelike structures like the sepals (Plate 2, fig. 6). They do not develop as much as do the sepals. Next to the last structure of the female flower to develop is the aril (Plate 2, fig. 8). The carpels develop and mature last (Plate 2, figs. 7 and 8).

On removal of the floral envelopes, there is seen around the apex of the pistil and near the stigmas some powdery white material which, upon scraping and mounting in water on a slide, is found to be composed of multicellular scales consisting of numerous thin-walled papillate cells, the free ends of which are rounded. Inclosed among them are large, round, more or less spheroid cells containing raphides. Möbius(6) observed them only on the young female and unopened flower. In my specimens these powdery white scales with specialized cells containing raphides were found, not only on the juvenile female flowers, but also on the juvenile rachis and rachillæ. They can be found also all over the spathes. These white powdery scales around the stigmas persist on the young fruit and disappear only when the fruit matures.

When the inflorescence emerges from the inner spathe, the ovules have already developed within the thick carpel wall. Each ovule possesses two coats (Plate 2, figs. 4 and 9; Plate 3, fig. 15). Extending from the stigmas is the conducting tissue composed of palisaded cells. This tissue trifurcates as it passes

down to the loculi, or cells, of the ovary. An anatropous ovule completely fills each of the loculi. Winton's(13) results agree with mine in showing that the ovary has three ovules, all of which are anatropous.

ORIGIN AND DEVELOPMENT OF THE STONY LAYER OF THE FRUIT

The fruit.—After fertilization, the growth of the fruit follows, the pericarp developing most rapidly at the basal region which remains soft and whitish until the fruit is nearly mature. Long before the time of fertilization (that is, before the pistils emerge from the floral envelopes) the endocarp is already differentiated as a soft, creamy white structure surrounding the loculi.

As the fruit develops and matures, the embryo sac increases in size, leaving a large vacuole at the center. The embryo sac is at first rounded, then it elongates and widens until near maturity. The fruit of the particular variety here reported upon loses its conical shape (Plate 2, figs. 2, 10, and 11) in the early part of the elongating period and becomes spheroidal to orbicular (Plate 2, figs. 12 to 16; Plate 3, figs. 1 to 5) as it matures.

When the fruit is young the mesocarp composes the major portion of the pericarp, being wider near the stigmas and sides and very narrow at the portion which attaches the fruit to the rachilla. During its development, the mesocarp up to maturity increases in thickness in the region opposite the stigmas, or near the micropylar end of the ovules. The exocarp always remains tough and hard, losing its green color when old, the final color varying with the variety. The number of fibrovascular bundles in the mesocarp increases with development, so that at maturity the fruit contains numerous fibers.

The stony layer.—Before the ovules are formed, the pericarp wall is homogenous in structure and is composed of isodiametric cells. As the loculi of the ovary develop, and just before the ovules are formed, the pericarp wall undergoes triple differentiation (Plate 2, fig. 8; Plate 3, fig. 6). The outermost layer of cells becomes squarish to elongated horizontally. The hypodermal cells are isodiametric. The cells within the hypodermis are large, and the innermost part of the pericarp wall is composed of small rectangular to squarish cells. The pericarp, then, has undergone differentiation long before the ovules are formed into (*a*) an outer single layer of squarish to elongated cells, the exocarp; (*b*) the large isodiametric cells of the mesocarp; and (*c*) the small isodiametric cells of the endocarp.

By the time of the appearance of the ovules, the mesocarp cells have already undergone advanced and complete differentiation. At the juncture of the stigmas and the ovary, the cells of the mesocarp which have rounded corners elongate horizontally and enlarge. Cell enlargement continues downward toward the basal portion of the ovary. Simultaneously with differentiation of the mesocarp is the appearance of the tanniferous cells, starting from the stigmas and continuing downward. Further differentiation of the mesocarp is marked by the production of more tanniferous idioblasts soon after the opening of the inner spathe (Plate 3, fig. 7). While the differentiation of the mesocarp is in progress, the endocarp cells remain isodiametric.

The exocarp cells, which remain always one layer in thickness, elongate tangentially and develop a thick outer wall (Plate 3, fig. 6) as they mature.

While the mesocarp undergoes differentiation, the endocarp remains as a clear, white structure in the innermost portion of the pericarp and starts its further differentiation soon after the mesocarp is differentiated. The cells have no tannin (Plate 3, fig. 7). The walls toward the loculi are lined by palisaded cells from the stigmatic point downward. Just adjacent to this single layer of palisaded cells, one to three rows of horizontally elongated, more or less compressed cells are evident. These are bordered within toward the mesocarp by isodiametric cells which become larger as they approach the loculi. Juvenile fibrovascular bundles are present (Plate 3, fig. 7). The peripheral cells of the endocarp at the micropylar end become vertically palisaded, becoming isodiametric at the hypodermis and within.

Further increase in size of the endocarp is due to further cell division and cell enlargement. The presence of elongated and isodiametric cells in either transverse or longitudinal sections of the endocarp is very conspicuous, especially in mature specimens, and this variable development is due to anticlinal and periclinal divisions of the cells. As the endocarp develops, the palisaded condition of the cells at the sides toward the loculi disappears and it persists only at the apical and basal regions. Some of these palisaded cells in the micropylar region divide, producing two or three layers of cells, and the cells assume either an oblique, a horizontal, or a vertical position (Plate 3, fig. 9).

The process of cell lignification (Plate 3, figs. 1 to 6) is similar to that found in *Sassafras sassafras*,(10) where lignification starts at the apical region and ends at the basal region. As lig-

nification proceeds to the basal region, it is seen first in the middle of the endocarp layer and progresses simultaneously inward and outward to the mesocarp. The lignified cells of the endocarp are at first colorless, but later turn yellowish brown and finally dark chocolate brown. The change in color, like the lignification, proceeds from the stigmatic point to the basal end of the fruit and from the middle toward the sides of the layer of the endocarp. The dark chocolate or chocolate brown color of the endocarp is its characteristic feature, in which it differs macroscopically from the mesocarp and also from the integumental layers.

Winton(13) found that the mature stone cells show variability in form; some are rounded, others oblong, and still others elongated (Plate 3, fig. 10). They are dark yellow under the microscope, but the whole layer is dark chocolate as seen by the naked eye. The walls are striated and traversed by simple and branching pores. The lumina are very small and contain a dark brown substance. The cells near the mesocarp have thinner walls and larger lumina than those near the ovary cavity.

The "eyes" show certain interesting morphological peculiarities. In a nut three eyes are present but, evidently, if only one embryo is developed, one eye becomes functional, and the other two are nonfunctional. Upon examination of a mature nut, the fertile eye appears to be a depression (Plate 3, fig. 5). The depression here is due to the failure of the endocarp (excepting a single layer of cells) to lignify. The remainder of the covering of this eye is composed of spongy parenchymatous tissue which morphologically belongs to the endocarp. The fertile eye, therefore, becomes covered only by a very thin plate of lignified cells formed from the palisaded layer of the endocarp and from the outer integument of the fertile ovule.

The morphology of the two sterile eyes varies from that of the fertile eye. The difference lies in the fact that, in the formation of the shell of the sterile eyes, tissues other than the outer integument of the fertile ovule and the palisaded layer of the endocarp take an active part.

Tangentially, the fertile eye (Plate 3, fig. 13) is a circular structure, at the periphery of which are located, vertically and obliquely, tubular cells of the endocarp (Plate 3, figs. 11 and 12).

Taxonomists generally regard the shell of the coconut as made up solely of the endocarp. Since not only the endocarp but also the outer integument of the seed contribute to the formation of

the stony layer, or shell, of the coconut, as a whitish yellow coating in the innermost portion of the shell, a discussion of the development of the latter becomes a necessity. This intimate relation of the outer integument and the endocarp was pictured by Winton.(13) The anatropous ovules at the basal portion of the ovary possess two coats, outer and inner integuments (Plate 2, fig. 4; Plate 3, fig. 15). These two coats in their juvenile stages are composed mostly of isodiametric cells, the peripheral cells of which are elongated and palisaded (Plate 3, fig. 15). As the ovules develop, vascular bundles are formed in only the outer integument (Plate 3, fig. 7). The cells of the inner integument remain small and isodiametric.

Only one of the ovules formed in the basal portion of the ovary becomes functional; the other two degenerate. As the fertile ovule develops and its embryo sac enlarges, it fills up one of the three loculi of the ovary. The other two loculi become compressed in the wall of the developing fruit. The outer integument of the fertile ovule and the endocarp of the pericarp wall come together (Plate 3, figs. 7 and 14). The two degenerated ovules, due to pressure resulting from the growth of the fertile ovule, are compressed also, and their cavities are reduced to lunar slits. Not only the outer integument of the fertile ovule, but also the outer integuments of the two degenerated ovules, come in contact with the endocarp.

Before the outer integument of the fertile ovule comes in contact with the endocarp of the pericarp wall, it consists mostly of isodiametric cells, small near the inner integument and increasing in size toward the periphery. The peripheral layer of the outer integument consists of palisaded to squarish cells. Vascular bundles are manifest (Plate 3, fig. 7). The inner integument consists of isodiametric cells of nearly uniform size, bordered by palisaded cells toward the embryo sac.

The outer integumental cells near the endocarp are larger and their walls very much thicker than either those in the middle of this integument or those toward the inner integument. Lignification of the outer integument precedes that of the endocarp. It begins at the apical region of the fruit and ends at the basal end and is, therefore, similar to that of the endocarp. As lignification proceeds to the basal end of the fruit, it progresses from the outer portion inward to the inner integument. However, at the fertile eye, lignification is seen first in the middle of the outer integument, and progresses simultaneously inward and outward

to the endocarp. With the exception of the cells bordering the micropyle of the fertile ovule, which are slightly lignified, lignification of the outer integument is rather homogenous throughout.

SUMMARY

The inflorescence of the coco palm begins as a protuberance at the axil of the petiole, at the base of which two primary bracts, outer and inner spathes, respectively, are cut off, the latter outgrowing the former as inflorescence develops. The main axis, rachis, then cuts off secondary bracts, at the axils of which primordia of the rachillæ (lateral branches) develop. The rachillæ, similar to the main axis (rachis), cut off bracts (tertiary bracts) at the axils of which the flowers arise.

The development of the female floral organs is centripetal, and is as follows: Scaly leaves, or bracteoles; sepals; petals; aril; and carpels.

The endocarp, which later constitutes the major portion of the stony layer, or shell, differentiates early; that is, before fertilization.

The stony layer is composed of the endocarp and the outer integument, as reported by Winton. The inner integument adheres to the endosperm as a thin brownish to reddish papyraceous coat.

Lignification of the endocarp proceeds from the stigmatic point of the fruit toward the basal region, and from the middle to the sides of the layer of the endocarp. Cell lignification is similar to that in *Sassafras sassafras*.

Lignification of the outer integument also proceeds from the stigmatic point of the fruit toward the basal end, and from the outer portion inward toward the inner integument. In the fertile eye, it is visible first at the middle and proceeds to the sides of the outer integumental layer. It precedes that of the endocarp.

The stone cells of the endocarp are greatly lignified and present a variety of forms. The cells of the outer integument are also lignified, but less so than the cells of the endocarp.

The depression at the eyes is due to the fact that most of the endocarp cells in the region do not lignify. Less tissue participates in the formation of the stony layer of the functional eye than in that of the other two eyes.

ACKNOWLEDGMENT

I wish to acknowledge my indebtedness to Dr. Eduardo Quisumbing, of the Department of Plant Physiology, College of

Agriculture, University of the Philippines, under whose suggestion, direction, and encouragement this work was undertaken.

BIBLIOGRAPHY

1 ANDY, PULNEY S. On branched palms in southern India. Trans. Linn. Soc. **26** (1870) 661–662.

2. BURKILL, I. H. An abnormality in the coconut palm. Journ. Roy. Asiatic Soc. Straits Branch No. **68** (1915) 15.

3. CHAMBERLAIN, C. J. Methods of plant histology. Chicago (1924) 343.

4. FURTADO, C. X. A study of the coconut flower and its relation to fruit production. Garden's Bull. Straits Settlements **3** (1924) 261–274.

5. FURTADO, C. X. Branched coconut palms and their fertility. Garden's Bull. Straits Settlements **3** (1924) 274–279.

6. MÖBIUS, M. Ueber Rhaphiden in Epidermizellen. Ber. Deutsch. botan. Gesell. **23** (1905) 485–489.

7. MÖBIUS, M. Die Perianthblätter von Cocos nucifera. Ber. Deutsch. botan. Gesell. **26a** (1908) 115–124, pl. 1.

8. PARTHASARATHY IYENGAR, M. O. Note on a bulbiferous coconut tree from Malabar. Journ. Ind. Bot. Soc. **3** (1923) 289–291, pl. 1. Cited in Bot. Abst. **14** (1925) 63.

9. PETCH, T. Abnormalities of the coconut palm. Ann. Roy. Bot. Gard. Peradeniya **6** (1915–1917) 25–29.

10. QUISUMBING, EDUARDO. Stony layer in seeds of gymnosperms. Bot. Gaz. **79** (1925) 121–195, pl. 11, figs. 1–88.

11. SMITH, J. J. Nieuwe misvormingen bij klappers. (New anomalies in cocoanuts) Teysmania **30** (1919) 291–297, pls. 1–4. Cited in Bot. Abst. **4** (1920) 151–152.

12. WIESNER, JULIUS. Die Rohstoffe des Pflanzenreiches. Leipzig (1903) 1070.

13. WINTON, A. L. Anatomy of the fruit of Cocos nucifera. Am. Journ. Sci. **12** (1901) 265–280.

ILLUSTRATIONS

PLATE 1. THE COCO PALM

FIG. 1. Portion of the spadix showing the rachis (*ri*), rachilla (*ra*) with male (♂) and female (♀) flowers. $\times 0.5$.
2. A single rachilla showing a basal female flower and male flowers. $\times 0.5$.
3. Median longitudinal section of the whole inflorescence showing primary bracts or spathes (*c*) and the beginning of the inner spathe (*i*). $\times 22$.
4. Tangential longitudinal section of the whole inflorescence showing the outer spathe (*os*) and the inner spathe (*is*). $\times 22$.
5. Median longitudinal section of the whole inflorescence showing the spathes (*os* and *is*) and the rachis giving rise to lateral secondary bracts (*sb*). $\times 22$.
6. Median longitudinal section of the rachis showing the basal secondary bracts during rapid elongation (*sb*). $\times 22$.
7. A much advanced stage of the development of the secondary bracts. $\times 22$.
8. Longitudinal section of the rachis showing the primordia (*p*) of the rachillæ emerging from the axils of the secondary bracts (*sb*). $\times 22$.
9. Portion of a longitudinal section of the rachis showing the rachilla (*ra*) already developed and differentiated. $\times 22$.
10. Portion of a longitudinal section of a rachilla showing tertiary bracts (*tb*). $\times 22$.
11. A longitudinal section of a much older rachilla showing the floral primordia (*p'*). $\times 22$.

PLATE 2. THE COCO PALM

FIG. 1. A portion of the base of the rachilla showing three developed female flowers with the lateral male degenerated flowers darkened. $\times 0.5$.
2. Lateral view of the female flower showing the petals (*pt*) and sepals (*s*). $\times 0.5$.
3. Cross section of the ovary to show the position of the ovules. Inner integument (*ii*), outer integument (*oi*), nucellus (*n*). $\times 30.75$.
4. Longitudinal section of the ovary to show the anatropous ovules. $\times 30.75$.
5. Longitudinal section of the young female flower showing the two scaly leaves (*sl*) and the beginning of the sepals (*s*). $\times 30.75$.
6. Longitudinal section of an older female flower with the tertiary bracts (*tb*), scaly leaves (*sl*), sepals (*s*), and petals (*pt*) developing. $\times 41.5$.

FIG. 7. Longitudinal section of a much older female flower, showing the perianth segments already developed. × 22.

8. Longitudinal section of a female flower with the aril (*a*) and with carpel (*a'*) walls already formed. × 22.

9. Longitudinal section of one of the anatropous ovules, showing the outer and inner integuments. × 65.5.

FIGS. 10 to 16. Diagrammatic drawings, showing the development of the fruit. × 0.25.

PLATE 3. THE COCO PALM

FIGS. 1 to 5. Diagrams of the longitudinal sections of the fruits, showing the trend of lignification. Basal end (*mi*), stigma (*st*), apical end (*ch*), inner integument (*ii*), outer integument (*oi*), endocarp (*en*), exocarp (*ex*), and mesocarp (*m*). ×0.125.

FIG. 6. Longitudinal section of the pericarp wall, showing triple differentiation of the pericarp into exocarp (*ex*), mesocarp (*m*), and endocarp (*en*). × 196.5.

7. Portion of a longitudinal section of the side of the ovary and fruit, from the embryo sac to the mesocarp (*m*). Note the vascular bundles (*vb*) in the endocarp and outer integument. × 196.5.

8. Portion of the pericarp, showing exocarp (*ex*) and mesocarp (*m*) well differentiated. × 196.5.

9. Portion of the palisaded cells (*pa*) of the endocarp at the micropylar region of the ovule. × 196.5.

10. Diagram of a longitudinal section of the endocarp and portion of the outer integument attached. × 72.25.

11. A strip of the tangential section of the eye from the micropyle to the endocarp, taken as shown in figs. 12 and 13. × 42.5.

12. Diagram of a radial section of the fertile eye, showing the inner integument (*ii*), outer integument (*oi*), palisaded cells of the endocarp (*pa*), and the endocarp (*en*). × 14.

13. Diagram of a tangential section of the fertile eye taken from the portion indicated in fig. 12. × 14.

14. Longitudinal section of a portion of the ovary, showing the integuments of the ovule still away from the endocarp (*en*), and the loculi (*li*) still present. × 196.5.

15. Longitudinal section of the anatropous ovule, showing the structure of the integuments. × 42.5.

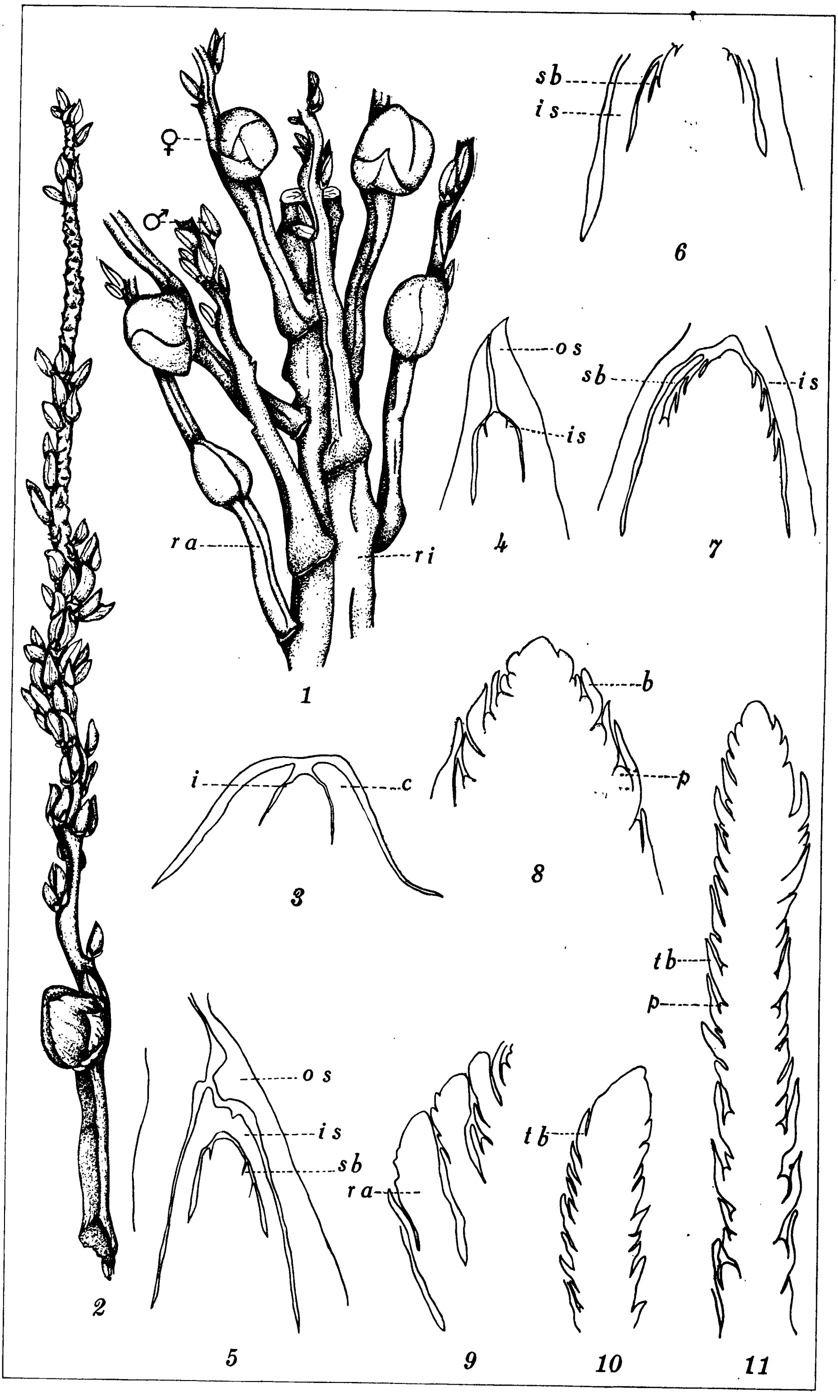


PLATE 1.

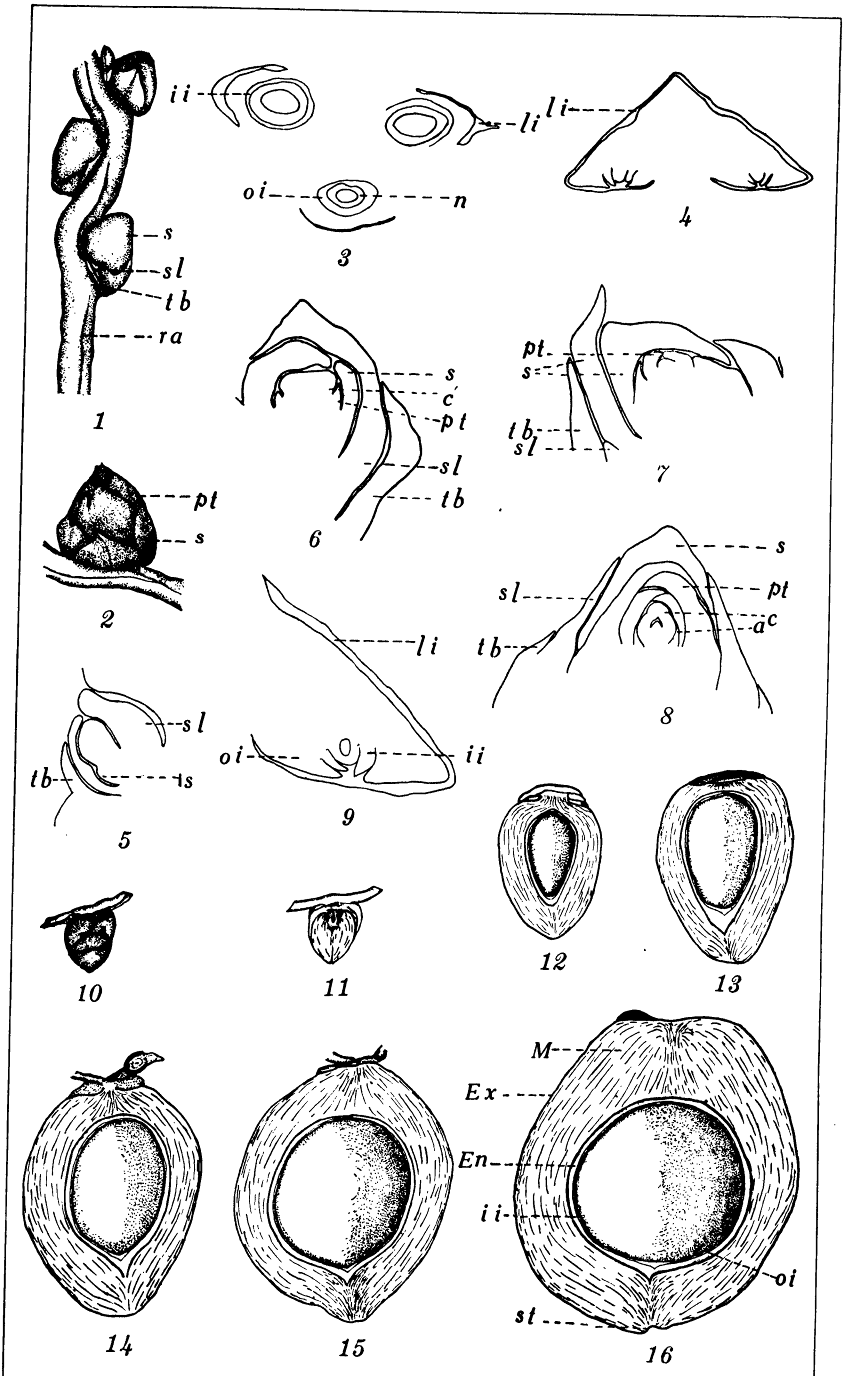

ii
li
li
oi
n
s
sl
tb
ra
1
3
4
pt
s
c'
pt
sl
tb
6
pt
s
tb
sl
7
2
s
pt
sl
c
a
tb
8
li
sl
s
tb
oi
ii
5
9
12
13
10
11
M
Ex
En
ii
oi
st
14
15
16

PLATE 2.

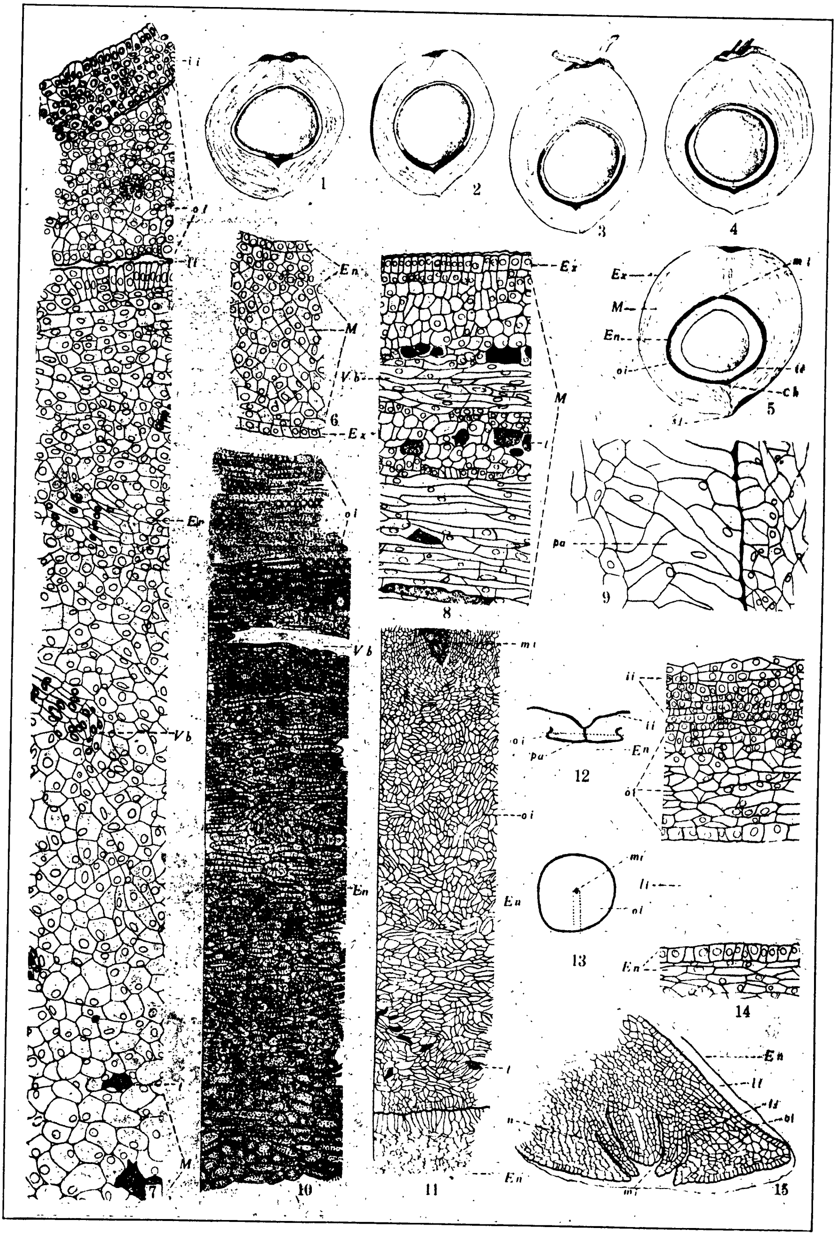


PLATE 3.

THE DEODORIZATION OF COCONUT OIL

By WALTER L. BROOKE

Chemist, Bureau of Science, Manila

INTRODUCTION

At the present time there is only one company in the Philippines engaged in the manufacture of refined deodorized coconut oil. This company uses the oil for making a lard compound, a coconut margarine, and a milk. The oil, after having been heated, is deodorized in 5-ton lots by blowing superheated steam through it in small streams under a vacuum. The vacuum is obtained by means of a barometric head. The vacuum and temperature, as well as the supply of steam, vary slightly during the operation; but the attempt is made to hold the temperature around 177 to 248° C. (350 to 400° F.) and the vacuum at 25 inches. The time of deodorization is usually nine to ten hours.

The substances that are volatile with steam are condensed and are carried along with the water which is passed through the barometric head to generate the vacuum. This water, heated slightly by the condensed vapors, together with the volatilized products is run into a large rectangular trough about 1.2 meters deep, where some of the volatilized products separate, rise, and float on the surface of the water. By placing a board over the outlet of the trough, the water can be made to flow out of the trough from underneath the surface. In this way, the water-insoluble products that are removed by this refining process can be collected. The product, as skimmed from the surface of the water, is a whitish or grayish, greasy, malodorous substance that slowly turns darker on exposure to air. In appearance it resembles vomitas more than anything else. It has a sour, acid odor coupled with a heavy, unpleasant, very persistent, somewhat aromatic one. The latter odor is especially noticeable in the deodorization room as soon as the process of deodorization is begun, and resembles the odor in a bodega where copra has been stored for some time.

The deodorization sludge changes in appearance as the operation proceeds. At first it is an oily liquid with a very greasy

feel. After about three hours' operation, solid white particles begin to appear and the substances now cover the surface of the water in the tank with a solid whitish scum. As the end of the deodorization is approached, the solid, tallowy, whitish substance predominates and the characteristic ketonic odor is barely perceptible.

The volatilized products were collected in five fractions to determine if the nonsaponifiable constituents came over mostly at the beginning or at the end of the operation. The material was skimmed from the surface and the water allowed to drain from it through filter paper, and it was then weighed while moist. It was then taken to the laboratory, saponified and steam-distilled, and the amount of nonsaponifiable matter was determined. The results of these determinations appear in Table 1.

TABLE 1.—*Nonsaponifiable content of the different fractions.*

Fraction.	Time of collection.	Weight of moist sludge.	Yield of nonsaponifiable substances.
		g.	*cc.*
1	7 a. m. to 9 a. m	512.0	54.0
2	9 a. m. to 11 a. m	510.0	98.5
3	11 a. m. to 2 p. m	2,087	52.0
4	2 p. m. to 4 p. m	2,476	10.0
5	4 p. m. to 5.30 p. m	1,065	4.0

A total of 218.5 cubic centimeters, or 179.17 grams, of nonsaponifiable substances was recovered from the 5 metric tons of coconut oil that had been placed in the deodorizer. This amount corresponds to a yield of 0.0036 per cent. This percentage of course does not represent the amount present in crude coconut oil, because a large amount is carried away with the tremendous quantity of water used to generate the vacuum during the nine to ten hours of operation. None of this water is used over again, because the colder the water, the more effective the operation of the barometric head.

The yield of the nonsaponifiable constituents from crude coconut oil was determined in the laboratory by distilling some crude coconut oil with steam. This distillation was performed on 2 kilograms of oil at a time; the temperature of the oil was maintained around 120° C., and the steam passed into it for

four hours. The water that separated from the distilled oil was used again, to generate steam. The results are tabulated in Table 2.

TABLE 2.—*Laboratory yields of nonsaponifiable constituents from crude coconut oil.*

Oil used for distillation.	Free fatty acid of original oil (as oleic).	Total oil distilled and carried over mechanically.	Nonsaponifiable constituents.		Yield of nonsaponifiable constituents.
kg.	*Per cent.*	*cc.*	*cc.*	*g.*	*Per cent.*
36	3.68	172	19.0	15.9	0.0441
44	2.15	200	21.3	17.9	0.0407

The amount of nonsaponifiable constituents obtained in this way is more than ten times that yielded when determined on the deodorization sludge as obtained from the plant, and confirms the supposition that much of the lower-boiling material is lost in the water used to generate the vacuum. The nonsaponifiable constituents recovered from the crude oil in the laboratory ought to contain a larger proportion of the lower-boiling, more water-soluble, odorous components than that obtained from the deodorization sludge of the factory. This supposition is verified by comparing Tables 3 and 5. Thurman [1] gives 0.40 per cent as the volatile water-soluble loss when coconut oil is deodorized. Salway [2] gives 0.03 per cent as the yield of neutral oil obtainable from coconut oil. By an examination of Table 2, it will be observed that the higher yield of nonsaponifiable constituents is obtained from the oil that has the higher free fatty acid.

The deodorization sludge can be divided into three parts: acidic substances, saponifiable substances, and nonsaponifiable substances.

ISOLATION AND PROPERTIES OF THE SUBSTANCE

At the beginning of this work, I was not familiar with the article of Haller and Lassieur [3] and consequently started to work in a different way. The coconut deodorization sludge was treated with excess sodium hydroxide with thorough agitation until it was ascertained that saponification was complete. After

[1] Industrial and Engineering Chemistry **15** (1923) 397.
[2] Journ. Chem. Soc. **3** (1917) 407.
[3] Compt. Rend. L'Acad. Sci. **150** (1910) 1013.

standing overnight it was steam-distilled. A little calcium chloride was added to keep down the frothing.

Haller and Lassieur also neutralized with caustic soda but they then extracted with bisulphite. I decided to use the steam-distillation method, as originally planned, in the hope of perhaps obtaining other substances in the low- and high-boiling fractions besides those isolated by the authors mentioned.

The steam-distilled product was heated with fresh caustic soda for about one hour, and then washed with distilled water until the wash water was only faintly alkaline. The product secured in this manner was dried over calcium chloride for several days. It had the following properties:

Specific gravity at $\frac{25°C.}{25°C.}$	0.82316 0.82315
Refractive index at 25°C.	1.4312 1.4312

This product is easily soluble in 95 per cent alcohol, ether, ethyl acetate, carbon bisulphide, chloroform, acetone, gasoline, or acetic acid. It is insoluble in water, dilute hydrochloric acid, dilute nitric acid, or ammonia. Concentrated nitric acid gives a reddish coloration.

The oil gave only a very slight optical rotation to the right.

The oil may be distilled under atmospheric pressure. The data from such a distillation, using 95 cubic centimeters, are presented in Table 3.

TABLE 3.—*Distillation of the oil.*

Temperature. °C.	Total distillate. cc.
217	([a])
227	5.0
230	25.0
233	50.0
235	60.0
239	70.0
241	75.0
248	80.0
261	85.0

[a] First drop.

This distillation shows that the middle fraction, boiling at from 227 to 235° C., constitutes the larger part of the oil. A vacuum distillation yielded the results shown in Table 4.

TABLE 4.—*Vacuum distillation of the oil.*

First trial.			Second trial.		
Total distillate.	Temperature.	Pressure.	Total distillate.	Temperature.	Pressure.
cc.	*°C.*	*mm.*	*cc.*	*°C.*	*mm.*
(a)	177	230	(a)	181	240
8.5	187	250	13.0	190	262
34.0	185.7	216	39.0	189	242
58.5	185.5	206	64.0	190	240
84.0	192.5	236	90.0	198	240
94.0	224.5	256	95.0	220	246

[a] First drop.

One hundred cubic centimeters of the substance were used for the distillation; 2.5 cubic centimeters were recovered in the distillation flask. The temperatures are uncorrected for exposed stem.

These distillations likewise show a large middle fraction boiling at around 185° C. under 210 millimeters pressure or, at 189° C., around 240 millimeters pressure.

If the distillation is performed under a higher vacuum (8 millimeters) such as is generated by a Cenco-Nelson pump, practically all of the low-boiling constituent is lost and condenses on the container before boiling begins.

The distillation of the nonsaponifiable constituents obtained from the 80 kilograms of crude coconut oil by steam distillation (see Table 2) after drying with calcium chloride, gave the results recorded in Table 5.

TABLE 5.—*Distillation of nonsaponifiable constituents secured from the laboratory deodorization experiments.*

Temperature.	Distillate.
° *C.*	cc.
0 to 195	(a)
195 to 205	0.5
205 to 210	1.5
210 to 220	10.5
220 to 230	19.0
230 to dryness	2.5

[a] One drop.

The nonsaponifiable part of coconut oil prepared in this way contains a larger proportion of lower-boiling constituents than does that prepared from the deodorization sludge obtained from the factory.

PREPARATION OF THE OXIME

The oxime may be prepared either in alkaline or in acetic acid solution. Twenty-two grams hydroxylamine hydrochloride and 44 grams of sodium acetate were dissolved in a little water in a flask, then 50 grams of undistilled ketone were added with a little 95 per cent alcohol to aid in bringing the ketone in solution. The contents of the flask were then boiled gently for one to two hours under a reflux. The reaction mixture, if allowed to cool, will separate into a lower aqueous layer, and an upper oily layer containing some crystals. The oxime is removed by ether extraction and washed with distilled water several times; then the ether is allowed to evaporate and the resulting oil is chilled in a refrigerator (9° C.). The crystals that separate are pumped from the oily mother liquor and recrystallized from aqueous alcohol. They melt at from 42.5 to 43° C. Haller and Lassieur give from 44 to 45° as the melting point of the oxime of methyl nonyl ketone. Because the oxime has so low a melting point it is rather difficult to recrystallize, as it melts and floats on the surface as an oil instead of dissolving.

After the identity of this ketone was definitely established by the preparation of ether derivative, the oxime was made of some of the fraction boiling at between 185 and 186° C. at 212 millimeters pressure. After it was recrystallized from aqueous alcohol once it melted at 43.5 to 44° C.

PREPARATION OF THE SEMICARBAZONE

Ten and seven-tenths grams of semicarbazide hydrochloride and 10.7 grams sodium acetate were placed in a flask with 20 cubic centimeters water, and then 20 cubic centimeters of undistilled ketone and 100 cubic centimeters of 95 per cent alcohol were added. This mixture was boiled with a reflux condenser until no more oil remained on the surface, and then three-fourths of an hour longer. When it was poured into a beaker of cold water a voluminous white precipitate formed which was filtered with suction, dried, and recrystallized from absolute alcohol. It consisted of beautiful white crystals which melted at 119° C. and remelted at 116° C. After recrystallization once from acetone and twice from absolute alcohol it melted at 120° C. and remelted at 116° C., which is in agreement with the findings of Haller and Lassieur for the semicarbazone of methyl nonyl ketone.

PREPARATION OF THE DIOXIME

To prepare the dioxime, 20 grams of the ketone were mixed with 8 cubic centimeters of concentrated hydrochlorine acid and cooled with ice; then 13.6 cubic centimeters of amyl nitrite were added, a small amount at a time. The mixture was shaken continuously and cooled so as to keep the temperature between 45 and 50° C. After all the amyl nitrite had been added, the reaction mixture was shaken for a half hour longer. Seventy-five cubic centimeters of a 2 per cent sodium hydroxide solution were now added to the product in a separatory funnel, shaken, allowed to separate, and then the lower alkaline layer drawn off. This operation was repeated six times. The sodium hydroxide fractions were distilled with steam a short time only, to remove amyl alcohol, because mononitroso methyl nonyl ketone is also rather volatile with steam. The amyl alcohol cannot be removed by ether extraction as Adams and Kamm [4] recommend in their directions for the preparation of dimethyl glyoxime, because the nitroso compound of methyl nonyl ketone is extracted from an alkaline solution by ether. [5]

By heating the alkaline solutions with hydroxylamine solution in an open beaker in a draft of air the amyl alcohol is also easily vaporized.

These steam-distilled residues were then treated with hydroxylamine hydrochloride which had been neutralized to litmus. A slightly discolored whitish solid began to separate at once. This mixture was heated on the hot plate for a half hour longer to complete the reaction, then allowed to cool, filtered, and recrystallized from aqueous alcohol. The slightly yellowish crystals obtained melted at 159° C. When this substance was washed with petroleum ether to remove monoxime, diketone, and monoketone, and then recrystallized again from hot aqueous alcohol, it melted at 161 to 162° C. Filetí and Ponzio give 162° C. as the melting point of this dioxime.

During the heating of the isonitroso ketone with the hydroxylamine solution, a pinkish color developed in the solution similar to that which occurs when dimethyl glyoxime is prepared by Adams and Kamm's method.

If the temperature of the reaction mixture of ketone and hydrochloric acid is allowed to rise to 55° C. during the addition

[4] Journ. Am. Chem. Soc. **40** (1918) 1287.
[5] Filetí and Ponzio, Gaz. Chim. Ital. 24 [2] (1894) 294.

of the amyl nitrite, a gas is generated in considerable amount and a yellowish oil is produced. This oil when heated with hydroxylamine also yields the dioxime. The ketone has probably been oxidized according to the following equation:[6]

$CH_3COCH_2C_8H_{17} + C_5H_{11}NO_2 = CH_3CO\ C\text{-}NOH\text{-}C_8H_{17} + C_5H_{11}OH$
$CH_3CO\ C\ NOH\ C_8H_{17} + C_5H_{11}NO_2 = CH_3CO\ CO\ C_8H_{17} + C_5H_{11}OH + N_2O.$

When the percentage of nitrogen in the dioxime was determined by Dumas's method the following results were obtained:

TABLE 6.—*Determination of nitrogen in the dioxime.*

Substance taken.	Moist nitrogen.	Temperature.	Pressure.	Nitrogen.[a]
g.	*cc.*	°*C.*	*mm.*	*Per cent.*
0.2024	24.6	30	759.5	13.11
0.2614	32.3	30.5	758.5	13.27

[a] Theory requires 13.08 per cent nitrogen.

The nonsaponifiable part of the deodorization sludge also contains some alcoholic constituents. These may be isolated by heating with phthalic anhydride, as Haller and Lassieur direct.[7] The product obtained by following their directions is a white glycerinelike substance with an odor somewhat similar to that of octyl alcohol. It is more soluble in water than methyl nonyl ketone but is still sufficiently insoluble so that it can be separated from the phthalic anhydride saponification product by steam distillation. It is optically active and rotates the plane of polarized light to the right. Haller and Lassieur state that this product consists of methyl *n*-heptyl and methyl *n*-nonyl carbinols.

The same authors have isolated methyl *n*-heptyl ketone from the lighter fraction and methyl *n*-undecyl ketone from the higher fraction of the nonsaponifiable part of the deodorization product. The first odor that issues from the end of a Liebig condenser when coconut oil is distilled with steam resembles that of an amyl compound. It is the same volatile, rather fragrant odor that is noticeable when one enters a copra bodega. However, no oil boiling around 152° C. could be isolated, although some oil can be obtained boiling around 195° C. and 263° C.

[6] Meyer and Jacobson, Lehrbuch der organischen Chemie, 2d ed. 1 [2] 824.
[7] Compt. Rend. L'Acad. Sci. 151 (1910) 697.

ANALYSIS OF THE ACIDIC AND SAPONIFIABLE CONSTITUENTS

This analysis was made on two samples collected about one month apart. The first sample represents the last two hours of deodorization, and the second sample the last four hours. The samples were prepared for analysis by allowing the excess water to drain off; then the material was placed in a beaker and beaten with a stirring rod until no more water could be obtained by slightly inverting the beaker.

METHODS OF ANALYSIS

The percentage of water was determined by the method described by Dean and Stark,[8] using 20 cubic centimeters of benzene and 80 cubic centimeters of xylene and a 20-gram sample. The acidity was determined by dissolving the sludge in neutral alcohol and titrating while still warm with half normal sodium hydroxide, using phenolphthalein as indicator. Then excess alkali was added and the oil saponified in the usual way by boiling and titrating the excess alkali with half normal acid. The ash was determined by placing about 10 grams of the sludge in a small porcelain dish, heating slowly until all the water was driven off, and then igniting by stronger heating and applying a flame. When the fatty material was nearly all burned the dish was placed in the muffle furnace and the ignition completed. The results of the analysis are given in Table 7.

TABLE 7.—*Analysis of the deodorization sludge.*

Sample.	Trial.	Water.	Acidity as lauric.	Saponification No.	Ash.
		Per cent.	*Per cent.*		*Per cent.*
1	1	19.5	31.8	72.2	3.15
	2	20.0	31.5	78.1	3.37
2	1	21.0	20.7	84.8	--------
	2	20.5	21.3	81.0	--------

Qualitative analysis of the ash shows the presence of sodium, calcium, magnesium, chlorine, and sulphate. These substances come from the brackish water used to generate the vacuum. The sludge also contained a substance which was acetone insoluble and resembled a calcium soap.

Part of sample 2 was dissolved in carbon tetrachloride and sodium carbonate added in excess with considerable agitation; the excess sodium carbonate and the soap resulting from the neutralization of the free fatty acids were then filtered off and

[8] Journ. Ind. Eng. Chem. 12 (1920) 486.

the carbon tetrachloride was removed from the oil by distillation. The oil thus obtained was neutral and slightly darker than ordinary coconut oil. Two determinations of the saponification number gave 251 and 253.

DISCUSSION OF RESULTS

Ketones are much more widely distributed in nature than was formerly supposed. This is especially true of methyl nonyl ketone. No attempt will be made to mention all the oils in which it has been found. Salway [9] found it in palm oil. Thoms [10] and Houben [11] definitely identified it in oil of rue, and recently it has been detected in oil of jaborandi leaves.[12] The rôle that methyl nonyl ketone plays in plant metabolism is not yet definitely established. However, the presence of this ketone in coconut oil can be accounted for when we take into consideration the constituents of coconut oil and their properties.

The percentages of the fatty acids in coconut oil according to Elsdon [13] are as shown in Table 8.

TABLE 8.—*The fatty acids of coconut oil, according to Elsdon.*

	Per cent.
Caproic acid	2
Caprylic acid	9
Capric acid	10
Lauric acid	45
Myristic acid	20
Palmitic	7
Stearic	5
Oleic	2

If we accept these percentages as approximately correct and associate them with the fact that ordinary mold fungi resolve fats into free acid and glycerine and then oxidize the resulting fatty acid into the methyl alkyl ketone with one carbon atom less, we can readily see why we would find methyl nonyl ketone in the product obtained from the deodorization of neutral coconut oil.

Fierz-David [14] states that the reaction is one of oxidation and the same ketones are obtained as are obtained by the oxida-

[9] Journ. Chem. Soc. Transaction **111** (1917) 407.

[10] Chemisches Centralblatt **72** 1 (1901) 524.

[11] Berichte der Deutschen chemischen Gesellschaft **35** 3 (1902) 3587.

[12] Chemisches Centralblatt **95** 2 (1924) 893.

[13] Lewkowitsch, Chemical Technology and Analysis of Oils, Fats, and Waxes, 6th ed. 2: 656.

[14] Zeitschrift Angewandte Chemie (1925) 6; also Analyst No. 590 **50** (1925) 244.

tion of the fatty acids by hydrogen peroxide and ammonia, according to the scheme of Dakin,[15] which is as follows:

$$R\ CH_2CH_2COOH \rightarrow R\ CH\ OH\ CH_2COOH$$
$$R\ CO\ CH_2COOH \rightarrow R\ CO\ CH_3 + CO_2$$

From the acids of coconut oil we would, therefore, expect to get the ketones listed in Table 9.

TABLE 9.—*Fatty acids and their corresponding ketones.*

Acid.	Ketone.	Boiling point of ketone.
		°C.
Caproic	$CH_3(CH_2)_2CO\ CH_3$	101.8
Caprylic	$CH_3(CH_2)_4CO\ CH_3$	151-152
Capric	$CH_3(CH_2)_6CO\ CH_3$	195
Lauric	$CH_3(CH_2)_8CO\ CH_3$	231.5-232
Myristic	$CH_3(CH_2)_{10}CO\ CH_3$	263
Palmitic	$CH_3(CH_2)_{12}CO\ CH_3$	294
Stearic	$CH_3(CH_2)_{14}CO\ CH_3$	319-320

One would expect to get very little methyl propyl or methyl amyl ketone, because of the low percentages of caproic and caprylic acids in coconut oil and the manner in which the oil is expressed from the copra where a temperature of 110 to 120° C. would be sufficient to volatilize the propyl and amyl ketones, especially when we consider that considerable water (5 to 6 per cent) is also volatilized at the same time by this treatment.

The quantity of tridecyl or pentadecyl ketone would likewise be small, because of the low percentage of the parent acids. The yields of the lower molecular weight ketones would also be less, due to their greater solubility in the water employed to generate the vacuum. From the distillation temperatures of the nonsaponifiable fraction of the deodorization product, methyl nonyl and methyl undecyl and methyl heptyl ketones should be present in the greatest amount. This is what one would expect from the percentages of lauric, myristic, and capric acids in coconut oil.

Methyl heptyl carbinol and methy nonyl carbinol no doubt arise from the reduction of the corresponding ketones, since Neuberg and Nord [16] found that this reduction may take place either photochemically or biochemically.

[15] Am. Chem. Journ. 44 (1910) 41.
[16] Report, Schimmel & Co. (April-October, 1920) 134.

SUMMARY

1. Methyl nonyl ketone was isolated from the product obtained from the deodorization of coconut oil, thus confirming the finding of Haller and Lassieur.

2. Its presence is established by the preparation and identification of the oxime, dioxime, and semicarbazone.

3. Most of the nonsaponifiable substances distill over in the first four hours of deodorization.

4. The yields of the nonsaponifiable constituents obtained from crude coconut oil in the laboratory and from the condensed deodorization sludge that was obtained from the factory are given.

5. The nonsaponifiable constituents also contain alcoholic compounds.

6. Two analyses of the crude acid sludge are given.

MINERAL CORDAGE OILS

By Walter L. Brooke

Chemist, Bureau of Science, Manila

INTRODUCTION

Abacá (Manila hemp) and abacá products constitute the third most important item of export from the Philippine Islands; in 1924 the exports amounted to 63,893,928 pesos. Since 1909 rope has been manufactured in the Islands in a factory equipped with modern machinery. At the present time there are five such rope factories in the Philippine Islands; they were equipped or incorporated in 1909, 1911, 1917, 1923, and 1924.

The Bureau of Science is occasionally called upon to analyze oils for cordage purposes which are submitted by competing salesmen, and to express an opinion on their relative value. Without definite specifications as a guide this is no easy matter. This lack of specifications prompted me to collect and publish what is known and thought about cordage oils and generally practiced in the Philippines, the hemp center of the world. This paper is a compilation of information gathered from manufacturers, from technical men engaged in the industry, from oil salesmen, and from personal observation. Many extreme opinions are omitted and this paper could very appropriately be called a résumé.

THEORETICAL CONSIDERATIONS

There are two main theories as regards the use of cordage oil; namely, it serves as a lubricant for the fibers during the process of manufacturing the rope and, subsequently, during the life of the rope. There must be sufficient lubrication so that the fibers will not become heated or worn. The other theory is that the oil serves as a medium for the dispersion of the fillers used in manufacturing the rope and displaces water in the fiber, thus preventing decay, mold, and deterioration. The oil soaks into the sclerenchyma fiber and the filler is deposited on the outside of the fibers where it lubricates the small filaments which constitute the rope. The latter theory seems to have some justification, for an ordinary dry rope will start to "drop" oil when it

is stretched to about 80 per cent of its tensile strength in a testing machine.

It is often claimed that the best rope ever made was treated with a fish oil. From a theoretical viewpoint, the use of an animal or a vegetable oil is entirely different from that of a mineral oil. The high price of animal and vegetable oils is the principal factor which has forced the change to a mineral one. The slow hydrolysis of a nonmineral oil with the liberation of fatty acid and glycerine no doubt helps the rope maintain some desirable properties, because the fatty acids as they are formed in situ among the fibers "wax" the strands.

There is no "waxing" when a mineral oil is used; neither is there any hydrolysis. Furthermore, even though the mineral oil be too high in the homologous series to have noticeable antiseptic action on molds, it at least does not furnish food for their growth. These circumstances are especially applicable if the rope is made in the rainy season when the moisture content of the fiber is high and the oil penetration poorer than usual. At the present time in none of the factories is the fiber dried before oil has been applied.

Viscosity of oil.—There is a direct and intimate relationship between viscosity and penetration into the fibers. If the oil is applied hot an oil of higher viscosity can be used than if it is applied cold. A light medium oil is considered about correct if it has good penetration. If its penetration is not so good, a lighter oil, one having a Saybold viscosity of 100 at 100° F., is used. In the temperate zone, the cold test would be of some importance; but in the Philippines, where the temperature extremes are so close together (65 to 96° F.) it has very little significance.

Volatility.—When kerosene is used to thin out an oil so as to increase its penetration, great inconvenience may result. A rope made with a kerosene-thinned lubricant may lose as much as from 8 to 10 per cent in weight upon storage in a bodega or in transit to the purchaser, thus necessitating adjustment of weights and prices on the purchaser's books, so that the amount received at the warehouse will check with the amount shipped. When such an adjustment has to be made between seller and buyer, the relations are not always the most cordial, and the impression is made on the buyer that he is buying oil at the price of rope. He is willing to buy rope by the pound, but he does object to buying rope that is filled with oil which is evaporat-

ing. The volatility of the eight oils that I examined was determined by weighing approximately 10 grams into a No. 0 low form porcelain crucible and heating for three hours at 110° C., and reweighing after it had cooled in a desiccator. Loss in weight is computed to percentage and recorded as volatility loss. With a temperature variation of 3° C. in the Freas electric oven, fairly concordant results can be obtained, as the results of the volatility loss of the eight oils analyzed show (see Table 1).

TABLE 1.—*Volatility loss of oils.*

Oil No.	Trial— 1	Trial— 2	Average.
	Per cent.	*Per cent.*	*Per cent.*
1	0.52	0.55	0.53
2	0.51	0.54	0.52
3	0.46	0.44	0.45
4	0 44	0.56	0.50
5	0.35	0.40	0.37
6	0.22	0.21	0.22
7	0.20	0.20	0.20
8	0.19	0.21	0.20

Acidity and sulphur.—The opinion of the trade is unanimous that mineral cordage oils should be free from acidity. The use of kerosene is objected to, not only because of its high volatility, but also because its use is likely to introduce acidity into the oil. Just what the real objection to acidity is, no one seems to know.

A high sulphur oil is considered objectionable, because it is thought that the sulphur in the oil becomes spread out into such thin layers on the fiber that it is oxidized to sulphuric acid, and that this then causes "pitting." [1]

Emulsifiability.—At the present time the emulsifiability tendencies of an oil play a very insignificant rôle in the selection of a rope oil; but where the rope is exposed to water, as in marine usage, this property assumes some importance. If the oil is easily emulsified it will soon be removed from the fibers and the rope will become dry, hard, and heated in use. It will then rapidly deteriorate by molding and rotting. This point is just now beginning to be considered. Some marine ropes have failed

[1] The appearance of small darkish spots in the rope accompanied by a considerable decrease in tensile strength.

in use, but whether the cause of failure was due to the kind of oil or to the particular fiber used is yet undetermined. The emulsifiability of the oil is offered as a possible explanation.

The emulsifiability of the eight oils under study was determined by Test No. 27 of the New and Revised Tag Manual for Inspectors of Petroleum,[2] page 100, to see if there was much difference between them. The results are reported as R. E. number, A. S. T. M. method. The results of analysis are given in Table 2.

TABLE 2.—*The R. E. number of the cordage oils, by the A. S. T. M. method.*

Oil No.	Trial—		Approximate average.
	1	2	
	Per cent.	*Per cent.*	*Per cent.*
1	4.0	4.0	4.0
2	4.0	5.0	4.5
3	7.0	6.5	6.5
4	5.0	5.0	5.0
5	5.0	6.5	6.0
6	4.0	5.0	4.5
7	7.5	8.0	7.5
8	7.0	6.5	7.0

Inspection of Table 2 shows that there is really little difference in the R. E. number of the oils offered to the Manila market.

Color.—A dark oil cannot be used for a light-colored rope; except for this restriction, color plays an insignificant rôle in the choice of a cordage lubricant. The opinion is general in the Philippines that only paraffine-base oils are used in the Eastern States for cordage purposes. This is supposed to account for the development with age of the desirable yellow color in the rope instead of the grayish or blackish color imparted when an asphaltum-base oil is used. The cost of transportation favors a California or Singapore refined oil for use in the Philippines.

Flash and fire points.—These physical constants have no real significance, except as they affect volatility and increase the fire hazard when the oils are applied hot.

Fillers, waxes, and nonmineral oils.—For the dispersion of fillers, such as talc, graphite, kaolin, etc., one oil is as good

[2] C. J. Tagliabue Mfg. Co., 18–88 Thirty-third Street, Brooklyn, N. Y.

as another. Animal or vegetable oils, degras, wool grease, paraffine wax, fish oil, etc., at least within the limits desired in practice, are as soluble in one mineral oil as in another. Talc is sometimes used to prevent "squeak" (a cracking noise when the rope is held tightly in the hands and bent). Some buyers demand a rope without a "squeak." They claim that it wears better, especially for heavy use over pulleys. Other buyers, as the Java trade, demand a rope with a "squeak." Sometimes an oil high in free fatty acid is mixed with a mineral oil and then neutralized with caustic soda, and this mixture of oil, soap, and water is used as a rope oil. It is claimed that it also prevents "squeak."

FINANCIAL CONSIDERATIONS

The determining factor in the selection of a cordage oil is price; all other considerations are secondary to it. When the price per kilogram of fiber is 40 centavos, that of tallow 25, and of degras oil 20, a mineral cordage oil ought to be purchasable for 15 centavos a kilogram. An oil, to be considered, must be available in sufficient quantities, and the supply must be steady, so that the process need not be changed by the use of a substitute oil pending the arrival of a shipment of the oil regularly used. The oil must be uniform in quality, to insure uniformity in manufacturing the rope. Other things being equal, an asphaltum-base oil is given the preference over a paraffine-base oil, because of the higher specific gravity of the former. A good fiber will absorb 22 per cent by weight of oil. The quantity of oil that a fiber will absorb depends on the season of the year or the water content of the fiber. A fiber that will absorb 14 per cent by weight of oil in the wet season can be easily made to absorb 16 to 18 per cent in the dry season. It can be readily seen that a manufacturer will favor a high gravity oil, which he can purchase at 15 centavos and sell for the price of rope. This, however, is a minor consideration, but one which nevertheless exerts some influence in the selection of a rope oil. Where rope is bought on specification, the rope of course cannot contain more oil than the specifications allow, usually 8 to 12 per cent.

METHOD OF APPLICATION

The oil is applied either hot or cold by spraying it on the hanks as they go to the combing machines. When the oil is applied

hot, it is applied at 130 to 150° F. Some manufacturers believe a hot oil penetrates better, especially when the fiber is moist, as in the rainy season, and also that the hot application of an oil helps prevent "squeak."

ANALYSES OF OILS OFFERED IN THE MANILA MARKET IN 1925

The eight oils were analyzed according to the regular procedure in mineral-oil analysis. The data are given in Table 3.

TABLE 3.—*Analyses of oils offered to the Manila market in 1925.*[a]

Oil No.	Specific gravity at 60° F.	Viscosity Saybolt, at 100° C.	Flash and fire points (Cleveland open cup).		Sulphur.	Volatility loss.	R. E. No.
			Flash.	Fire.			
			°F.	*°F.*	*Per cent.*	*Per cent.*	
1	0.919	107	311	358	0.18	0.53	4
2	0.923	105	315	354	0.35	0.52	4.5
3	0.916	98	307	351	0.40	0.45	6.5
4	0.923	102	316	356	0.50	0.50	5.0
5	0.916	96	316	356	0.40	0.37	6.0
6	0.938	132	336	392	0.21	0.22	4.5
7	0.888	91	343	390	0.36	0.20	7.5
8	0.940	146	343	395	0.21	0.20	7.0

[a] Oils 5, 6, 7, and 8 were used in largest quantity.

SUMMARY

1. A résumé of the theories, ideas, opinions, facts, and practices regarding the selection and use of mineral cordage oils in Manila is given.

2. The analyses of the mineral cordage oils offered to the Manila market by jobbers in the early part of 1925 are also given.

Acknowledgment is hereby made to Mr. E. F. Gutierrez, of the Bureau of Science, who determined the sulphur in these oils; to the various oil companies who kindly furnished me with samples of their oils; and to various members of the cordage trade who gave me information and assistance.

BLOOD-CHEMISTRY STUDIES IN LEPROSY [1]

I. NONPROTEIN NITROGENOUS SUBSTANCES, SUGAR, AND CHLORIDE

By Ernesto M. Paras

Junior Chemist, Philippine Health Service, Culion Leper Colony

Despite the large amount of work that has been done on the chemistry of the nonprotein constituents of blood in various diseases, especially nephritis, in connection with which blood-chemistry studies have been considered to be of great importance by various investigators, no work on the blood analysis of lepers seems to have been done.

In 1922 when injections with chaulmoogra-oil derivatives were extended to all possible cases at Culion, it was found that tuberculous and nephritic lepers were unsuitable, continued application of the treatment having been found to be detrimental if not disastrous to such patients. The following year, Dr. Eloy V. Pineda,(8) assistant pathologist at Culion Leper Colony, basing his conclusions on three hundred autopsies performed by him, reported that nephritis was a common occurrence in the colony and that it stood second in frequency in causing death among the inmates. According to him it appears also that antileprosy drugs given to the afflicted persons cause kidney impairment, as indicated by the findings in urinalyses carried out in the Culion pathological laboratory in which, out of 1,120 specimens of urine examined, 95 per cent were positive for albumin and 88 per cent contained casts. In view of the foregoing and of the importance now attached to the chemical analysis of blood, which appears to be rapidly overshadowing the importance formerly attached to urinalysis, it is evident that a chemical investigation of blood constituents in lepers is a study which should no longer be neglected.

As a preliminary paper, the present report constitutes a comparative quantitative study of certain blood constituents;

[1] Read at the meeting of the Culion Medical Society, May 29, 1925. Published with the approval of the Director of Health.

namely, nonprotein nitrogen, urea nitrogen, uric acid, preformed creatinine, sugar, and chloride in the blood of one hundred lepers and of seventeen normal persons. The normal individuals from whom blood was taken were nonlepers from among the laboring class and the professional staff, who were presumably normal. The lepers' blood was taken from cases in the general hospital, in the dispensary, and in the treatment clinics. For certain reasons many hospital patients who had lepra reactions or nephritis were taken for examination.

The immediate object of the present report is the accumulation of data that will show the extent of retention of body metabolic products in lepers, with the added purpose of determining the relationships of these data to urinary findings, to the condition of leper patients, to the antileprosy treatment, and to duration of the leprosy. Among other clinical factors that should be thoroughly studied and correlated are types of leprosy, diet, and drug therapy. Discussion of these is not included in the present paper since it is understood that they will be reported by the physicians in charge of the patients.

For obvious reasons, the data that have been collected for lepers were arranged under five general headings (see Tables 3, 4, 5, 6, and 7), the groupings being based upon the condition of the subjects at the time the blood was drawn from them. Thus, Table 3 presents cases (mostly of the mixed type) without complications or the less commonly occurring symptoms. In Table 4 were placed the cases with miscellaneous complications, or special symptoms not shown by the cases presented in Table 1, such as malaria, ulcers, neuralgia, etc. Table 5 is of lepers with tuberculosis. Table 6 includes cases with lepra reaction but without nephritis. Table 7 shows cases with nephritis, presenting clinical symptoms.

It will be noted from the accumulated data that the uric acid determination was omitted in most cases; the omission is due to the fact that the method used for this determination during the early portion of the work gave unreliable results. In the latter part of the work Benedict's method(1) was used.

METHODS EMPLOYED

Blood specimens were drawn either before breakfast or three and a half hours later and were worked up as soon as possible to avoid any chemical change taking place. In view of the fact

that practically all data on normal standards and pathologic changes reported in the literature were obtained with blood taken before breakfast, it might be supposed that the values I obtained with blood taken three and a half hours after breakfast would not give comparable values. However, variations in concentration of the various constituents of blood taken before breakfast and of that taken three and a half hours after eating were thoroughly studied by Hammett,(6) who found practically no difference. Furthermore, the usual Culion breakfast is light, and Dr. H. W. Wade, chief pathologist, states that samples taken as early as 9.30 a. m. give sera that rarely show distinct digestive (lipoid) clouding.

Blood samples were conveniently collected in test tubes (100 by 25 millimeters) to which 1 cubic centimeter of 2 per cent sodium oxalate solution dried in an oven had been added. Prepared in this way the sodium oxalate in the tubes seemed to serve as an anticoagulant better than in any other yet tried.

Among the anticoagulants I have employed lithium oxalate in the form of cloth, as suggested by Otto Folin in his latest manual, seemed to have no advantage over other oxalates, such as potassium and sodium. On the contrary, unless the lithium oxalate solution saturated the cloth very thoroughly and the drawn blood was shaken vigorously, coagulation was hardly preventable. The objection to the use of potassium oxalate powder is that it causes precipitate formation in the colorimetric uric acid determination.

In the main, the technic of Otto Folin and Wu(2) was closely adhered to. For preliminary removal of proteins, whole blood (7 cubic centimeters was usually sufficient) was laked with seven volumes of distilled water in a 250-cubic centimeter Erlenmeyer flask. Then one volume of 10 per cent sodium tungstate was added. The whole contents of the flask were thoroughly mixed, after which one volume of two-thirds normal sulphuric acid was introduced, the flask being constantly shaken while the acid was added slowly, so as to prevent any clumping of proteins. The whole contents were filtered, the filtrates being invariably water clear and neutral to Congo red. The importance of checking up the quality of sodium tungstate and of having a correct two-thirds normal sulphuric acid for blood protein precipitation in order to obtain blood filtrates suitable for subsequent analysis of various blood constituents was em-

phasized by Otto Folin in 1922. From the blood filtrates, the determination of various blood constituents was made; for nonprotein nitrogen, urea nitrogen, preformed creatinine, and sugar, the method of Folin and Wu (2) was followed. For the uric acid determination the new method of Benedict was used. Fleming, the only investigator, so far as I am aware, who has made blood analysis of Filipinos, used the same method. One reason for selecting Benedict's method was that precipitation, decomposition, and transfer of the final solution are eliminated, which otherwise would theoretically tend to cause slight loss. His method is simpler and permits more accurate colorimetric comparison than does Folin's. It might be stated that the reliability of results from the use of the latter method has been a matter of controversy recently between these two eminent biochemists. The method of Benedict seems, however, to have been the choice of many investigational workers on blood.

For the determination of urea, the urease-aëration method of Folin was followed, this having been found convenient for making several determinations at a time. In this method, urease paper instead of the alcohol jack-bean extract, as formerly adopted by Folin, was employed.

Quantitative determinations were sometimes run in duplicate and sometimes in triplicate. Analyses were repeated in all cases where there was the slightest doubt of the accuracy of the results. In a few cases showing unusually high values, a second analysis was made of the blood from the same patient, collected at a later date. No significant change was noted in these cases. Whole blood was used for all the determinations.

REAGENTS

All of the chemicals used in the analyses were of the highest grade of purity. The uric acid standard solution and 5 per cent sodium cyanide were prepared fresh at least once a month, and the standard sugar solutions, except the stock, were changed once every two weeks. Other standard solutions and reagents seemed to keep indefinitely.

In the nesslerization process, unless the Nessler reagent is correctly prepared, turbid solutions are formed when added to solutions containing ammonia. Folin remarked that Stand-

fords in 1923 stated that "No condition could be discovered in which clear solution could be obtained by direct nesslerization as suggested by Folin." He added that Cole in 1920 stated also that he was unable to repeat his experiments because of the turbidity of the resulting solutions. The main difficulty which they encountered lies undoubtedly in the percentage or amount of alkali used in nesslerization. At the start of this work I studied the cause of turbidity, which I also experienced, and found that by having an exact 10 per cent solution of sodium hydroxide accurately titrated, the turbidity when added to ammonia solutions was avoided and that the Nessler solution itself never separated as much green precipitate as is usually produced when it is incorrectly prepared.

PRESERVATION

Blood filtrates which were examined the day after the blood was drawn were preserved with 1 drop of toluene and kept in the refrigerator.

APPARATUS

All comparisons were made in a 5-centimeter Duboscq colorimeter. All apparatus used was chemically cleaned. All pipettes were calibrated to deliver.

BLOOD FINDINGS IN NORMAL INDIVIDUALS

As a basis of comparison and in order to check the technic followed, I examined the blood of seventeen presumably normal Filipinos (see Table 1).

In Table 2 the range of values in Table 1 is compared with the normal range as given by other investigators. It can be noted that the values representing the range within which the various substances were found to fluctuate, excepting the value for urea nitrogen, agree in general with the values found by Fleming. (3)

The difference in value for urea nitrogen may probably be attributed to the difference in technic followed, three methods having been adopted in the Folin-Wu system of blood analysis. Unfortunately, Fleming did not specify which of these methods he employed.

TABLE 1.—*Blood-chemistry findings in normal individuals.*

[Milligrams per 100 cubic centimeters of blood.]

Name.	Nonprotein nitrogen.	Urea nitrogen.	Uric acid.	Preformed creatinine.	Sugar.	Chloride (NaCl).
						Per cent.
G	30.0	14.0		1.0		0.49
N	25.5	18.0		1.5	80	0.49
D	33.0	13.0		1.1	160	0.49
?	30.0	13.2		1.5	120	0.46
P. M	25.5	12.7	3.6		102	0.47
I. O	27.0	12.7	4.4		99	0.50
R. V	31.5	16.0	3.0		102	0.45
G. H	28.5	16.0	3.2		80	0.47
J. A	30.0			1.5	80.3	0.49
D. A	27.1	18.0	3.2	1.4	84.8	0.44
J. M	32.0	11.4	2.9	1.4	85	0.44
J. R	25.5	7.3	3.2	1.3	85.8	0.42
E. P	25.5	13.5	4.0		95	0.49
M. C	23.0	19.0		1.5	92	0.46
P	27.0	12.7	4.4		99	0.46
P C	31.5	16.0	3.0		102	0.45
P	28.5	16.0	3.2		80	0.47
Average	28.3	14.3	3.5	1.2	96.7	0.46

TABLE 2.—*Normal ranges of blood chemistry as given by various investigators.*

[Milligrams per 100 cubic centimeters of blood.]

Author	Nationality studied.	Nonprotein nitrogen.	Urea nitrogen.	Uric acid nitrogen.
Gettler and Baker (4)	American	30–45	12–25	
Schamberg and Brown (9)	do	26–37	10–18	1.3–3.5
Gradwohl and Blaivas (5)	do	25–30	12–15	1–3
Squire, Bandler, and Myers (10)	do	25–35	12–15	2–3.5
McLean and Selling (7)	do	23–44	12–27	
Fleming (3)	Filipino	25–33.3	8.4–13	3.2–4.8
Paras	do	23–33	7–19	2.6–4.4

Author.	Preformed creatinine.	Sugar.	Chloride (NaCl).
			Per cent.
Gettler and Baker (4)		58–120	
Schamberg and Brown (9)	1–1.1	66–120	
Gradwohl and Blaivas (5)	1–2.5	80–120	0.65
Squire, Bandler, and Myers (10)	1–2.5	90–120	0.45–50
McLean and Se ling (7)			
Fleming (3)	1.3–1.5	93–160	
Paras	1–1.5	80–160	42–49

In general it may be noted that the agreement between my figures and Fleming's is much closer than that among the values reported by other investigators for normal white persons, as shown in Table 2. The variation as found by these investigators is not surprising, however, as there are numerous analytical methods of blood analysis available, some of which were worked out by the cited authors themselves.

BLOOD FINDINGS IN LEPERS

An inspection of Table 3, representing individual cases of leprosy without complication, shows that the values obtained were practically normal, except the nonprotein nitrogen values for cases 38, 42, and 94, which are above normal. Other cases, in which the leprosy shows the same or a greater degree of advancement, however, give entirely normal figures for nonprotein nitrogen. The extent of leprosy is stated in only about half of the cases. No records were available for the other cases because they were hospital patients not receiving antileprosy treatment. It appears, however, that chronic leprosy directly affects the concentration of blood constituents little, if at all, and that there is no regular correspondence between any of these constituents and the extent or type of the leprosy.

Table 4, representing cases of leprosy with miscellaneous complications, shows also essentially normal figures, except for cases 13, 31, and 72, which gave abnormal figures for nonprotein nitrogen.

In cases with tuberculosis (Table 5) the chemistry findings are practically normal, except in cases 19, 44, 64, and 65, which gave also abnormal figures for nonprotein nitrogen. Only case 68 showed abnormal figures for urea and uric acid.

In Table 6, cases with lepra reaction, the blood findings were in many cases above normal. The contrast with Table 3, showing chronic leprosy, is marked.

In cases of leprosy with nephritis (Table 7) the blood findings are typical of nephritis. The most significant findings are those in cases 25, 26, and 33. These patients have died since, and autopsy findings established uremia as the cause of death.

In studying the average data obtained for the various groups of cases (Table 8), it will be noticed that the average values for nonprotein nitrogen, uric acid, creatinine, and sugar are all somewhat higher in the leper groups than in the normal group, whereas the value for nonprotein nitrogen is especially high,

not only in the nephritis group as would be expected, but also in the group of patients with lepra reaction. The urea nitrogen is essentially normal in the first three leper groups, but this also is high, not only in the nephritis group, but also in the lepra reaction group. The chloride is normal throughout.

In Tables 3 to 7 the following abbreviations and symbols are used:

Sc = Slight, cutaneous.
Mc = Moderate, cutaneous.
Mn = Moderate, neural.
CE = Chaulmoogra ethyl esters without iodine.
CEI = Chaulmoogra ethyl esters with 0.5 per cent iodine.
CEI Cr = Chaulmoogra ethyl esters with creosote.
Mer = Heiser-Mercado mixture of chaulmoogra oil, olive oil, camphor, and resorcin.
Sodium morrhuate = Rogers's sodium morrhuate from cod-liver oil.
I = Improved.
md = Moderate.
sl = Slight.
Stat = Stationary.
+ = Traces.
++ = Positive.
+++ = Abundant.
— = Negative result of test.
? = No record.
0 = No antileprosy drugs were given.

SUMMARY AND CONCLUSIONS

1. The methods and results of the chemical analysis of blood in one hundred lepers and in seventeen presumably normal individuals are reported. The lepers were classified in the following groups: Those without complications, those with miscellaneous complications, those with tuberculosis, those with lepra reactions, and those with nephritis.

2. The blood values taken as normal for the various constituents were as follows: Nonprotein nitrogen, 23 to 33 milligrams; urea nitrogen, 7 to 19 milligrams; uric acid, 2.6 to 4.4 milligrams; preformed creatinine, 1 to 1.5 milligrams; sugar, 80 to 160 milligrams; chlorides, calculated as sodium chloride, 0.42 to 0.49 per cent. All figures were calculated as per 100 cubic centimeters of whole blood.

3. The results obtained from normal individuals are compared with those obtained by other investigational workers.

TABLE 3.—*Blood-chemistry findings in cases of leprosy without complications.*

Case No.	Duration of leprosy.	Extent of leprosy.	Antileprosy treatment.			Urine.		Non-protein nitrogen.[a]	Urea nitrogen.[a]	Uric acid.[a]	Preformed creat-inine.[a]	Sugar.[a]	Chloride. (NaCl).
			Kind.	Duration.	Results.	Albumin.	Casts.						
	Years.			*Months.*									*Per cent.*
30	14					+	—	35.3	11.6		1.5	118	0.49
38	2	Sc Mn	CEI	18	I md	+	+	46.1	17.3		1.7	181	0.47
39	9	Mc Sn	CEI	18	I sl	+	—	37.5	11.8		1.7	109	0.47
42	4	Sc Mn	CEI	18	I md	+	—	46	13.1	—	1.6	95	0.46
43	3	Mc Mn	CEI	18	I sl	?	?	34	13	—	1.4	122	0.44
47	11					?	?	38	17	—	1.4	130	0.47
49	2					+	—	28	13.5	—	1.5	111	0.50
52	2					+	—	30	—	—	1.5	111	0.45
53	5	Sc Mn	CEI	18	I md	—	—	26	16.5	—	1.5	98	0.45
54	3	Mc Mn	Mer	18	Stat	+	—		19.5	—	1.5	97	0.46
58	3	Mc Mn	Mer	18	I sl	+	+	32.5	15	—	1.4	100	0.47
59	2	Sc Sn	CEI	18	I sl	+	—	27	13	—	1.5	117	0.56
60	3	Mc Mn	CEI	18	I md	?	?	25	10.9		1.5	95	0.35
63						?	?	37	13.1	4.6	1.3	103	0.48
86						?	?	25.5	10.5	4.2	1.8	100	0.49
94	10					?	?	40	12.3		1.5	125	0.44
Average								33.8	13.4	4.4	1.5	113	0.46

[a] Milligrams per 100 cubic centimeters of blood.

TABLE 4.—*Blood-chemistry findings in cases of leprosy with miscellaneous complications.*

Case No.	Duration of leprosy.	Complications.	Antileprosy treatment.	Urine.		Nonprotein nitrogen.[a]	Urea nitrogen.[a]	Uric acid.[a]	Preformed creatinine.[a]	Sugar.[a]	Chloride (NaCl).
				Albumin.	Casts.						
	Years.										*Per cent.*
13	4	Ulcers, feet	?	?	?	41.4	8.7		1.7	143	0.49
20	2	Wound, post-operation	?	+	+	27.3	11.3		1.4	181	0.49
22	13	Psychosis	?	?	?	25.5	9.9		1.3	100	0.51
31	4	Neuralgia	?	?	?	46.1	15		1.4	108	0.51
35	17	Psychosis	Chaulmoogra oil	+	—	26.6	12		1	95	0.47
70	12	Bronchitis, chronic	Mercado and CEI	+	+	30	16.5	5.6	1.4	73	0.46
72	?	Ulcers, feet	?	?	?	48	22.5	5.6	1.5	119	0.46
74	9	Anemia; uncinariasis	CEI	+	+	26.7	11.9	4	1.8	105	0.49
75	?	Ulcers, multiple	?	?	?	27	13.6	3.4	1.5	85	0.49
77	?	Arthritis	?	?	?	37	15	4.2	1.5	143	0.49
78	7	Ulcer, chronic	Mercado and CEI Cr	+	+	30	18.4	4	1.5	75	0.47
80	3	Neurasthenia	CEI	+	—	26	18	4	1.5	95	0.47
90	3	Malaria, acute	Chaulmoogra oil	+	—	27	17	4.3	1.7	95	0.46
91	14	Psychosis	Mercado and CEI	++	—	25.5	15	3	1.7	100	0.48
93	4	Dysentery	?	?	?	27	11.5	4	1.6	80	0.47
Average						31.4	14.4	4.21	1.5	106	0.48

[a] Milligrams per 100 cubic centimeters of blood.

TABLE 5.—*Blood-chemistry findings in cases of leprosy with tuberculosis.*

Case No.	Duration of leprosy.	Antileprosy treatment.	Urine.		Non-protein nitrogen.[a]	Urea nitrogen.[a]	Uric acid.[a]	Preformed creatinine.[a]	Sugar.[a]	Chloride (NaCl).
			Albumin.	Casts.						
	Years.									*Per cent.*
15	4	?	0	0	36	11.7	......	1.4	93	0.49
16	8	CEI and Mer	......	......	28.5	......	......	1.5	123	0.49
19	14	Sodium morrhuate	++	+	69	20	......	1.8	110	0.50
29	7	Chaulmoogra mixture	+	+	30	8.2	......	1.3	95	0.46
44	10	CEI	+	+	41.4	13.2	......	1.5	107	0.44
55	......	?	......	......	29	14	......	1.5	105	0.49
64	10	CEI	+	+	43.5	17.6	3.2	1.5	93	0.49
65	10	CEI and Mer	+	+	36	13.5	4.3	1.5	117	0.46
68	4	?	......	......	42	30	5.6	1.5	114	0.39
76	4	?	......	......	30	11.3	4.3	1.3	90	0.52
87	2	?	+	—	28.5	16	4.8	1.7	85	0.44
95	8	?	......	......	36	9.3	......	1.6	160	0.49
Average	......	......	......	......	37.6	13.3	4.64	1.5	108	0.47

[a] Milligrams per 100 cubic centimeters of blood.

TABLE 6.—*Blood-chemistry findings in cases of leprosy with lepra reaction.*

Case No.	Duration of leprosy.	Antileprosy treatment.	Urine.		Non-protein nitrogen.[a]	Urea nitrogen.[a]	Uric acid.[a]	Preformed creatinine.[a]	Sugar.[a]	Chloride (NaCl).
			Albumin.	Casts.						
	Years.									*Per cent.*
1	6	?	?	?	26.1	11		1.6	107	0.48
2	6	?	?	?	46.8	15.8		1.1	77	0.49
4	5	CEI	+	+	22.2	7		2	107	0.48
5	10	?	?	?	45	28.5		1.4	130	0.47
7	7	0	++	+	63	12.7		1.8	189	0.57
10	5	CEI and Mer	+	—	49	30		2	110	0.47
24	13	?	+	—	29	12.5		1.2	120	0.51
27	3	CEI–Camph	+	+	37.5	9.4		1.4	114	0.41
34	1	CEI	+	+	27	7		1.4	77	0.47
36	5	?	?	?	30	8.6		1.1	100	0.51
40	8	?	?	?	39	12.4		1.5	117	0.49
45	2	?	?	?	70	36.6		1.5	140	0.47
46	8	?	?	?	75	41.1		1.5	133	0.48
48	5	?	?	?	40	19.3		1.4	125	0.46
51	3	CEI and Mer	—	—	50	25		1.4		0.49
52	4	CEI	+	—	60	28.5		1.5	105	0.46
67	8	?	?	?	48	18.7	4	1.4	116	0.56
71	11	?	+	+	33	21	4.8	1.4	129	0.52
73	10	?	+	—	33	15	3.6	1.3	108	0.49
82		CEI	+	+	33	18.7	4	1.4	96	0.46
83		CEI	+	+	30	15	4.1	1.4	94	0.51

84		?	?	?	51	25.4	4.8	1.8	154	0.54
88	16	?	?	?	36.5	13	3.2	2	100	0.47
89	8	?	?	?	33	13	4.4	1.5	95	0.49
92	16	Mer	+	—	25.5	12.7	4	1.7	120	0.52
96	5	?	?	?	34.6	12.8	4.4	1	77	0.52
Average					41	19.3	4.13	1.5	109	0.49

[a] Milligrams per 100 cubic centimeters of blood.

TABLE 7.—*Blood-chemistry findings in cases of leprosy with nephritis.*

Case No.	Duration of leprosy.	Antileprosy treament.	Urine.		Non-protein nitrogen.[a]	Urea nitrogen.[a]	Uric acid.[a]	Preformed creatinine.[a]	Sugar.[a]	Chloride (NaCl).
			Albumin.	Casts.						
	Years.									*Per cent.*
3	5	?	?	?	52	20		1.9	150	0.47
6	10	?	?	?	27.6	7.2		1.5	117.6	0.52
8	15	CEI	+	+	36	8.4		1.9	133	0.44
9	13	?	?	?	45	21.4		1.9	200	0.46
11	4	?	+	+	53.1	18		1.5	130	0.56
12	3	?	+	+	52.2	18		1.8	256	0.41
14	3	Sodium morrhuate	+	+	44.4	9.6		1.6	85	0.47
17	11	?	?	?	30	11.7		1.9	105	0.51
18	6	Mer	+	+	35	11.2		1.4	166	0.49
21	7	CEI	+	+	70.5	15		1.8	57	0.38
23	6	Sodium morrhuate	+	+	27.2	15		1.6	178	0.46
25	4	?	++	++	353	100		2.4	263	0.44
26	10	?	?	?	103	43		2.3	114	0.56
28	6	CEI and Mer	+	+	40	9.9		1.3	80	0.49
32	9	CE and CEI	+	+	33	10.1		1.2	108	0.49
33	12	Mer	+++	+	200	150		7.5	250	0.49

[a] Milligrams per 100 cubic centimeters of blood.

TABLE 7.—*Blood-chemistry findings in cases of leprosy with nephritis*—Continued.

Case No.	Duration of leprosy.	Antileprosy treament.	Urine.		Non-protein nitrogen.[a]	Urea nitrogen.[a]	Uric acid.[a]	Preformed creatinine.[a]	Sugar.[a]	Chloride (NaCl).
			Albumin.	Casts.						
	Years.									*Per cent.*
37	13	CEI	+	+	34	8.3		1.5	166	0.57
41	4	CEI	+	—	30	8.5		1.6	89	0.49
50	5	CEI	++	—	45	21.9		1.4	133	0.49
57	4	?	?	?	30	15		1.3	121	0.47
61	11	CEI	+	+	109	36.1		1.5	174	0.37
62	4	CEI	+	++	39	15	2.3	1.3	114	
66		CEI	+	+	27	17.2	3.2	1.4	166	0.42
69	2	CEI	+	+	42	22	4.8	1.3	105	0.49
79	6	CEI	+	—	34	23	4	1.5	80	0.49
81	3	CEI	+	+	26	12.7	4.6	1.9	90	0.49
85		CEI	+	+	46.4	21.6	4.2	1.8	160	0.54
97	4	?	?	?	62	46		1.3	111	0.49
98	3	?	?	?	55	17		1.7	117	0.51
99	8	?	?	?	60	19		2.5	166	0.49
100	5	CEI	+	—	57.7	18		1.1	75	0.41
Average					45.4	24.8	3.85	1.8	137.4	0.46

[a] Milligrams per 100 cubic centimeters of blood.

TABLE 8.—*Blood-chemistry findings; group averages.*

Table.	Condition of cases.	Nonprotein nitrogen.[a]	Urea nitrogen.[a]	Uric acid.[a]	Preformed creatinine.[a]	Sugar.[a]	Chloride
							Per cent.
1	Normal nonlepers	28.3	14.3	3.5	1.2	96.7	0.46
3	Lepers without complications	33.8	13.4	4.4	1.5	113	0.46
4	Lepers with various complications	31.4	14.4	4.21	1.5	106	0.48
5	Lepers with tuberculosis	37.6	13.3	4.64	1.5	108	0.47
6	Lepers with lepra reaction	41.06	19.3	4.13	1.5	109	0.49
7	Lepers with nephritis	45.4	24.8	3.85	1.8	137.4	0.46

[a] Milligrams per 100 cubic centimeters of blood.

4. A study of the results collected brings out the following facts:

(*a*) No regular correspondence can be traced between the blood findings and the duration, extent, or type of leprosy, or the antileprosy treatment.

(*b*) The average values for nonprotein nitrogen, uric acid, creatinine, and sugar for all of the leper groups were somewhat high, although many individual cases showed normal values.

(*c*) The average values for nonprotein nitrogen and urea nitrogen are markedly high, not only in the group of lepers with nephritis, but also in the group with lepra reactions.

(*d*) The group averages for urea nitrogen are normal except as above stated, and those for chloride are normal throughout.

ACKNOWLEDGMENTS

I wish to express my appreciation to Dr. Granville A. Perkins, chief chemist, Culion Leper Colony, for his valuable advice and suggestions in connection with the preparation of this paper; and to Dr. Froilan Eubanas, of the medical section, for his kind coöperation, including the furnishing of most of the blood specimens.

REFERENCES

1. BENEDICT, STANLEY R. The determination of uric acid in blood. Journ. Biol. Chem. Baltimore 51 (1922) 187–207.
2. FOLIN, OTTO. Lab. Manual Biol. Chem. (1923).
3. FLEMING. Journ. Metabolic Research 4 (1923).
4. GETTLER, A. O., and W. BAKER. Chemical and physical analysis of blood in thirty normal cases. Journ. Biol. Chem. 25 (1916) 211.
5. GRADWOHL and BLAIVAS. Blood and Urine Chem. (1920).
6. HAMMETT, F. S. Studies of variations in the chemical composition of human blood. Journ. Biol. Chem. 41 (1920) 599–615.

7. McLEAN, F. C., and L. SELLING. Urea and total nonprotein nitrogen in normal human blood: Relation of their concentration to rate of elimination. Journ. Biol. Chem. **19** (1914) 31–38.
8. PINEDA, ELOY V. Pathological survey of the causes of death in lepers at Culion. Journ. Philip. Is. Med. Assoc. **4** (1924) 175.
9. SCHAMBERG, J. F., and H. BROWN. The relationship of excess of uric acid in the blood to eczema and allied dermatoses based on an analysis of over two hundred cases. Arch. Int. Med. **32** (1923) 203.
10. SQUIRE, J. B., G. BANDLER, and V. C. MYERS. Significance of chemical blood findings in urologic conditions. Journ. Am. Med. Assoc. **79** (1922) 1384.

COLLEMBOLA FROM THE PHILIPPINES AND NEW CALEDONIA

By EDUARD HANDSCHIN

Of the University of Basel, Basel, Switzerland

TWO PLATES

In June, 1924, a small collection of Collembola was sent to me by C. F. Baker of Los Baños in the Philippine Islands. They were collected on Mount Maquiling, in central Luzon.

The little apterous insects reported herein are the first forms of their group to be recorded for the Philippines. For that reason they are important, not only for zoögeographic investigation but also for systematic.

This collection furnished the following four species, two of them new to science:

Ceratimeria pulchella sp. nov.
Achorutes bakeri sp. nov.
Lepidocyrtus parvidentatus Schaffer.
Pseudoparonella setigera C. Börner.

A *Lepidocyrtus* and an *Aphysa* were represented by young individuals which could not be identified.

At the same time I add two forms, collected by Dr. F. Sarasin and Dr. J. Roux in New Caledonia, of which one especially is of the highest importance as representative of a new genus. The two forms are—

Hypogastrura longispina Tullb.
Chaetoceras sarasini g. et sp. nov.

Ceratimeria pulchella sp. nov. Plate 1, figs. 1 to 6.

Length, 2.5 millimeters. Body color above dark purple, marked with nine large white spots; two are on the lateral and posterior parts of the head, two lateral on the median parts of Th. II and Abd. II, two on the sides of Abd. IV, and a median one on Abd. V. The conus of the mouth parts, the fourth joint of the antennæ, the legs, and all sternal parts of the body beneath are entirely ivory white. On the legs only a small triangular spot at the base of the subcoxæ remains purple. The antennæ are four-jointed and lie underneath the head at the side of the conus of the mouth parts. Fourth joint of antennæ with

simple bristles; third with apical antennal organ, composed of a pair of curved papillæ and two short guard setæ. Eyes 8 + 8. Postantennal organ composed of 27 tubercles in a deep groove; several of the tubercles in a middle row, as has been observed in *Ceratimeria longicornis* E. H. from Java. The unguis is simple, without teeth either on the inner or on the outer margin. Unguiculus absent. No tenant hair on the tibiotarsus. Furcula well developed. Mucrones a third as long as the dentes. The granulation of the skin of the latter continues on to the inner lamella of the mucro. Mucro simple, not hooked apically, subtriangular in form.

Ceratimeria pulchella is closely allied to *Ceratimeria maxima* Schott from New Guinea and the Sunda Archipelago and *Ceratimeria longicornis* from Java. It differs from both in the general shape, the color, and the structure of unguis and mucro.

The single specimen of this striking, well-defined species is preserved in my collection.

LUZON, Mount Maquiling (*Baker*).

Achorutes bakeri sp. nov. Plate 1, figs. 7 and 8.

Length, 2 to 3 millimeters. Color entirely white. Body with segmental humps, especially pronounced on the sides and dorsolaterally; each with long, stiff, naked bristles; all setæ without special structure. Antennæ short, four-jointed, fourth joint with somewhat excentric, retractile, subapical papilla and six to seven olfactory setæ on the outer side; the sense organ on third joint of normal structure, as in other species of the genus. Mouth parts for sucking. Three unpigmented eyes on each side, two close together just before the outer bristle hump, which bears the third eye on its back. A sort of postantennal organ before the first two eyes, the surface of which shows a fine granulation of the epidermis. Skin grossly tuberculated. Tubercles on the humps arranged in lines, running toward the apical bristles. Claw without teeth, but basally with a fine toothlike lamella. Unguiculus and tenant hairs absent.

Achorutes bakeri differs from other oriental species of the genus by the number of ommatids in the eye, the presence of the postantennal organ, the naked bristles, and the toothless unguis. The collection contains about ten specimens.

The species is named for C. F. Baker, to whose kindness I owe the material, and who collected it on Mount Maquiling, Luzon.

Lepidocyrtus parvidentatus Schaffer. Plate 2, figs. 9 and 10.

Lepidocyrtus parvidentatus was discovered by Schaffer in 1898. As it is necessary to have complete diagnoses illustrated with figures for the identification of the very difficult species of *Lepidocyrtus,* I here add drawings and a new description of the Philippine form, which I believe may be identified with the old species, *parvidentatus.*

Color brownish, scales somewhat darker. Violet pigmentation between the antennæ on the head and also on the antennæ. The body, especially the sides of Abd. II and IV, and the dorsal and ventral sides of Abd. IV violet. The proximal part of Abd. IV with a series of longitudinal violet stripes. The femora of all legs dark violet, except on the first leg, where only the coxæ are dark colored. The scales are rounded on both sides. The hair covering is especially dense on the legs, the antennæ, and the furca. Proportions: Ant. I:II:III:IV=5:12:12:20; Head: 42; Abd. III:IV=10:75; legs (tibiotarsi) I:II:III=20:28:40. (One specimen shows in Abd. III:IV only 7:43). Upper claw slender, with two inner teeth; lower claw long, without tooth, inner margin not truncated or cut off squarely. Tenant hair long. Mucro with long apical hook. Inner hook small and basal spine hardly visible.

LUZON, Mount Maquiling (*Baker*).

Pseudoparonella setigera C. Börner.

This form has also been recorded from the Malay Archipelago. Börner described it from Tjibodas in Java, and in material belonging to the Buitenzorg Museum it was present from the Lampong District in Sumatra. It seems, therefore, that the species has a wide geographical dissemination through all the islands of the East Indian Malayan seas.

LUZON, Mount Maquiling (*Baker*).

The specimens from Sumatra and the Philippines show no morphological differentiation.

Among the material collected by Dr. F. Sarasin and Dr. J. Roux in New Caledonia in 1910 are two vials containing specimens of Collembola, representing two species. One of these is the well-known cosmopolitan form *Hypogastrura longispina* Tullb.

According to the communication of Doctor Roux, the form occurred in huge masses upon the surface of small pools in the

forest. No difference can be observed between the individuals of New Caledonia and those of Europe.

The other form represents a genus of the Paronellini, not known until this time.

Genus **CHAETOCERAS** novum

Body long, slender. Antennæ more than twice as long as the body, underneath with long stiff bristles, sometimes of the length of a joint. Furca broad, nearly as long as the body. Mucro smooth, not disarticulated from the dentes, with coarse teeth. Body covered with broad, dense, serrated bristles.

The genus seems to connect Paronellini with Cremastocephalini. The nearest form may be Schott's *Paronella queenslandica;* but there are still wide differences in the hooks of the mucros, the form of the bristles, and the specific antennal setæ. The latter, especially, I have never observed in any other genus of the whole group.

Chaetoceras sarasini sp. nov. Plate 2, figs. 11 to 14.

Length, 2 to 3 millimeters. Body long, slender, color yellowish, with pink stripes on the dorsum of Abd. IV. Eyes on black spots, 8 on each side. Antennæ more than twice as long as the body (170:348) Ant. I:II:III:IV=60:78:50:170. The first three joints underneath with long, stiff bristles, often longer than a joint. Antennal joints III and IV finely annulated. Antennal organs were not observed. Mouth parts for chewing. Body segments: TH. II:III; Abd. I:II:III:IV:V:VI=25:20:8:10:8:85:9:4. Legs with bristles even as long as those on the antennæ. Ti. I:II:III=51:55:69. Claw with two inner teeth and a large outer one. Inner claw simple, the inner edge without tooth. Tenant hair as long as the claw. Furca long. Ma.: DeMu.=63:70. Dentes basally and apically of the same size. Mucro not disarticulated from the dentes, coarse, with two teeth. Body covered with broad, dense, somewhat scalelike, plumose bristles. Long stiff bristles always smooth.

Habitat, Ngoi Valley, New Caledonia (*Sarasin*).

BIBLIOGRAPHY

BÖRNER, C. Das System der Collembolen. Mitt. Nat. Hist. Mus. Hamburg **23** (1906) 147–188.

BÖRNER, C. Zur Collembolenfauna Javas. Tijdsk. Ent. **56** (1913) 44–61.

CARPENTER, G. H. The Apterygota of the Seychelles. Proc. R. I. Acad. **33** (1916).

FOLSOM, J. W. East Indian Collembola. Bull. Mus. Comp. Zool. Harvard University **65** (1924) 505–517.

HANDSCHIN, E. Collembolen aus Java. Rev. Suisse Zool. **28** (1920).

IMMS, A. D. On some Collembola from India, Burma and Ceylon. Proc. Zool. Soc. London (1912) 80–125.

OUDEMANS, J. T. Apterygota des Indischen Archipels. Zool. Erg. Weber. Leyden **1** (1890) 73.

SCHAFFER, C. Die Collembola des Bismarck-Archipels. Arch. f. Naturg. I **64** (1898) 393.

SCHOTT, H. Apterygoten von Neu Guinea und den Sundainseln. Termesz. Fuzetek. **24** (1901).

SCHOTT, H. Results of Mr. E. Mjöbergs Swedish Scientific Expeditions to Australia, 1910–1913. Collembola. Arkiv f. Zool. No. 8 **11** (1917) 1–60.

ILLUSTRATIONS

Plate 1

Plate 2

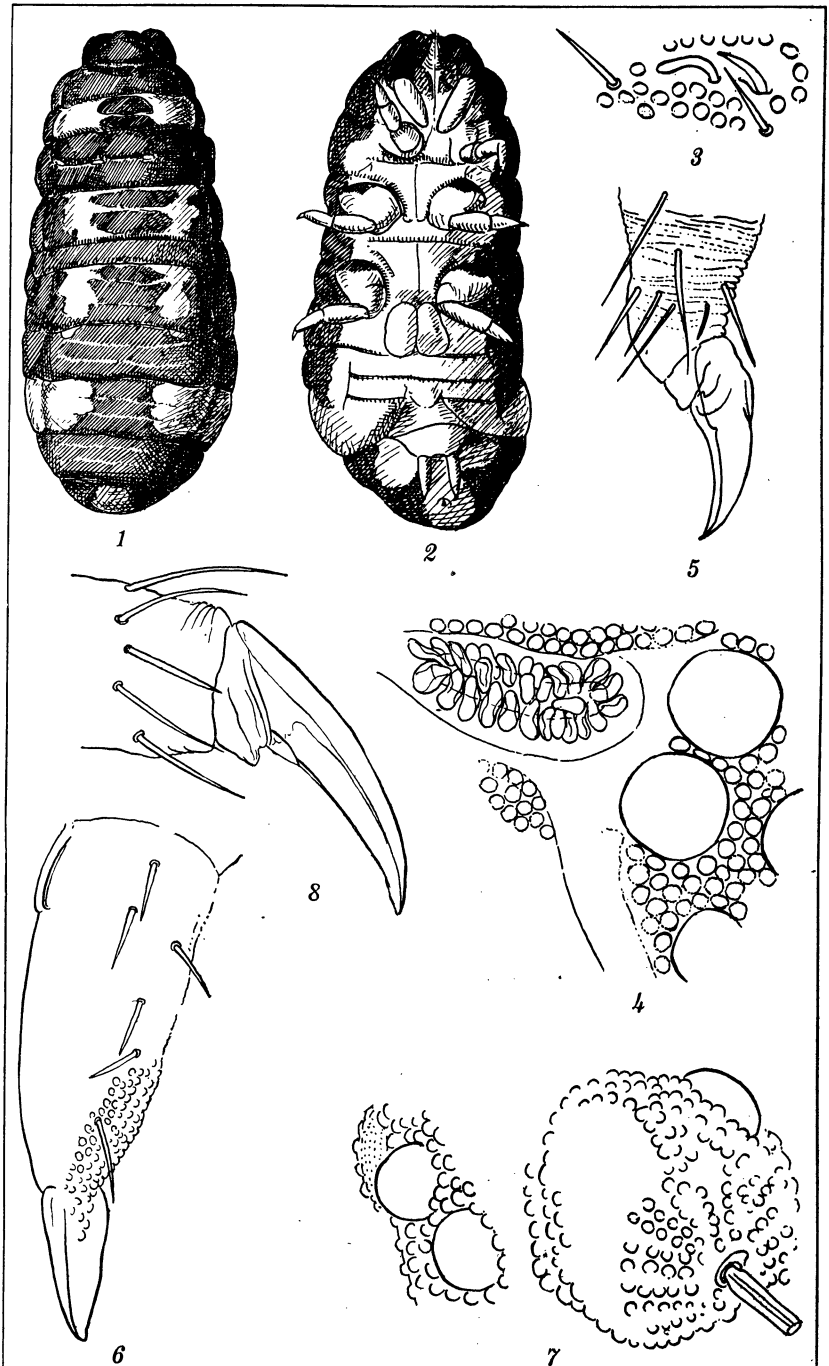


PLATE 1.

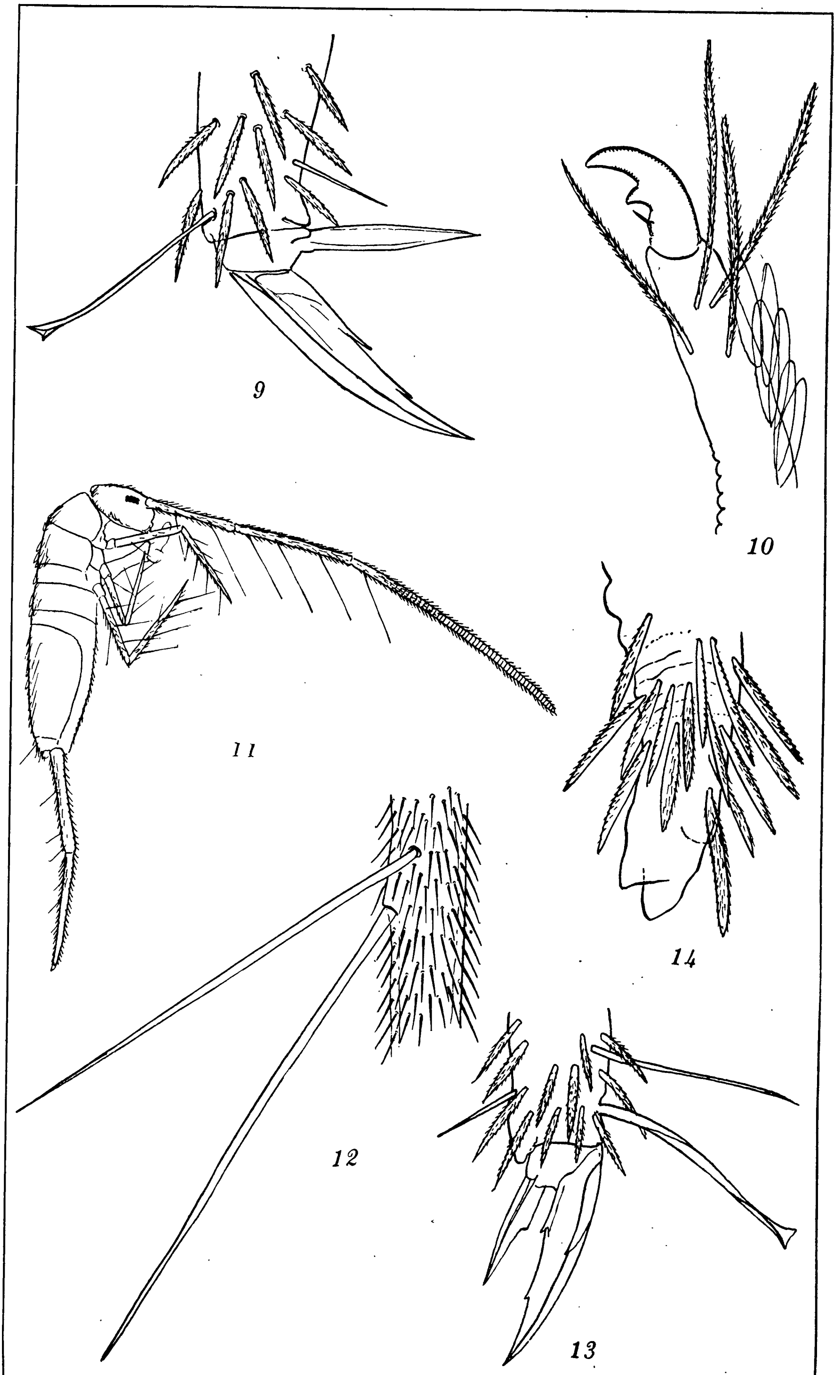


PLATE 2.

DIOCALANDRA TAITENSIS (GUERIN) AND OTHER COCONUT PESTS OF FANNING AND WASHINGTON ISLANDS

By William B. Herms

Professor of Parasitology, University of California, Berkeley

EIGHT PLATES AND THREE TEXT FIGURES

The investigation of which this paper constitutes a report is the result of a request to the College of Agriculture of the University of California from the London owners of Fanning and Washington Islands through their San Francisco agent for assistance in the identification and control of certain coconut pests prevalent on those islands. In order to undertake this work I was granted a four-months leave of absence, and on April 10, 1924, sailed from San Francisco on the company's motor schooner *Doris Crane,* arriving at Fanning Island May 3, after a voyage of twenty-three days. It is a matter of great satisfaction to be able to tender my hearty thanks to the representatives of the company (Fanning Island, Ltd.), both in connection with the voyage and during the progress of the work on the islands, for the kind treatment received. Thanks are particularly due to Mr. D. B. Crane who arranged the San Francisco details; Capt. John McCulloch of the *Doris Crane;* Maj. C. Burn-Callander, manager of Fanning and Washington Islands, who at all times accorded me the heartiest coöperation; and to my volunteer assistant, Mr. Harold Kirby, jr., graduate student in zoölogy, who accompanied me throughout the trip. Although I left Fanning Island for San Francisco via Honolulu on July 27, certain observations were nevertheless continued by Mr. Kirby until his departure, October 3.

Fanning and Washington Islands belong to a group of equatorial islands of the Pacific Ocean lying in a northwesterly-southeasterly position about midway between the Hawaiian and the Society Islands. The four main islands of this group are Christmas, nearest the equator (1° 57′ north latitude and 157°

27′ west longitude);[1] Fanning, about 145 miles northwest (3° 54′ 38″ north latitude and 159° 23′ 27″ west longitude); Washington, located 66 miles northwest of Fanning; and Palmyra, 126 miles northwest of Washington. Fanning is the most important of these islands, primarily because it is the seat of a British cable station, and also because it is a source of considerable quantities of a superior grade of copra. Other than through cable connection, Fanning Island is reached at intervals of about two months by steamers of the Union Steamship Company plying between Auckland, New Zealand, and Vancouver, British Columbia, and by the Fanning Island, Ltd., motor schooner *Doris Crane,* which sails at irregular intervals between San Francisco and Fanning and Washington Islands, and on recruiting trips to the Gilberts and South Sea Islands.

Fanning Island (fig. 1) is a typical coral atoll, consisting of a narrow rim of land hardly three-fourths of a mile in width

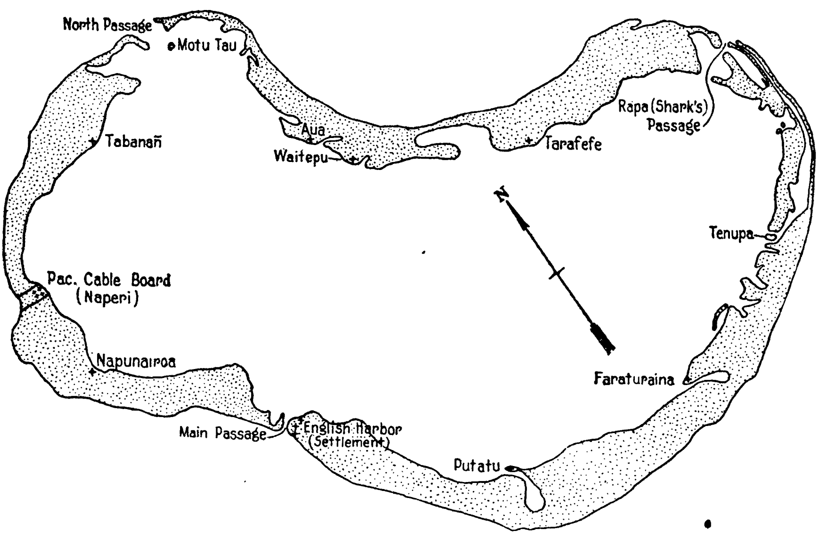


FIG. 1. Fanning Island, Pacific Ocean.

at the most and inclosing a lagoon. The island is approximately 10.5 miles long and 5.5 miles wide, with an external circumference of 31 miles. The rim of land at the outer edge, consisting of coral bowlders and shingle, is thrown up somewhat like a wall and is about 10 feet above mean tide level; the rest of

[1] Edmonson, Charles Howard. Crustacea from Palmyra and Fanning Islands. Bernice P. Bishop Museum Bull. 5 (1923) 1–43, pl. 1, 2.

the land is only 2 to 6 feet above mean tide level. For perhaps 200 feet inland from the sea the shore is strewn with coral bowlders and shingle of irregular shapes and sizes, often very jagged. There are three passages into the lagoon; namely, the Main Passage on the east side, with a minimum width of 850 feet, and navigable; Rapa, or Shark, Passage on the east side, with a minimum width of 525 feet; and North Passage on the north side, with a minimum width of 2,000 feet. Neither Rapa nor North Passage is navigable and with the Main Passage roughly divide Fanning into three smaller islands.

The total area of Fanning Island comprises about 8,500 acres, of which over 3,200 acres are in coco palms, approximately one-third of which are wild trees. In order properly to care for the harvesting of nuts, labor camps are located at intervals on the island. These camps are located as follows, and this information will assist in making comparisons later on in this report; namely, English Harbour (the Settlement), Company Headquarters, located at the Main Passage (south side) on the west side of the island with a labor camp near by; Fareturaina, located at the south-southeast end; Tenupa, at the southeast end; Tarafefe, at the northeast side with Shark Passage, or Rapa, between it and Tenupa; Aua, on the north side, separated from Tabonañ at the northwest end by North Passage; Naperi, the Pacific Cable Board; Napunaiaroa, situated on the west side about halfway between the Cable Station and the Main Passage.

During the course of this investigation the various points were reached mainly, first by launch and then on foot, through the bush adjacent to the several camps. The Napunaiaroa division was easily reached either from the Cable Station (by launch) or from the Main Passage after crossing by launch, while the Fareturaina and Tenupa divisions were reached on foot or for part of the distance by means of a Ford truck. Aua and Tarafefe were always made by launch, while Tabonañ was reached either by launch or via the Cable Station. A part at least of practically every day during the length of our stay was spent in the bush among the coco trees, and often the entire day was used in the pursuit of field observations. Through the thoughtfulness of the manager, Major Burn-Callander, we were given ample laboratory space at English Harbour, where breeding experiments and other laboratory observations were conducted and where the adequate supply of instruments, such as microscopes, thermograph, hygrograph, and

other equipment supplied by the University of California, could be used to good advantage.

The opportunity for the study of the Washington Island situation was too limited to carry on a detailed investigation. This island was visited May 13 to 16 inclusive (less than four days), the trip from Fanning having been made by the *Doris Crane* during the night of May 12. Owing to an unhappy landing in a small surf boat during a heavy sea, I sustained a painful injury which, together with other handicaps, made a study of the island rather difficult; however, through the ever thoughtful assistance of Major Burn-Callander, much was accomplished nevertheless. At the time of our visit the island had not been inhabited for about four months, and then only for a very brief period; hence the plantation did not present a very good condition. The island had really not been under care for about one and a half years, according to the manager.

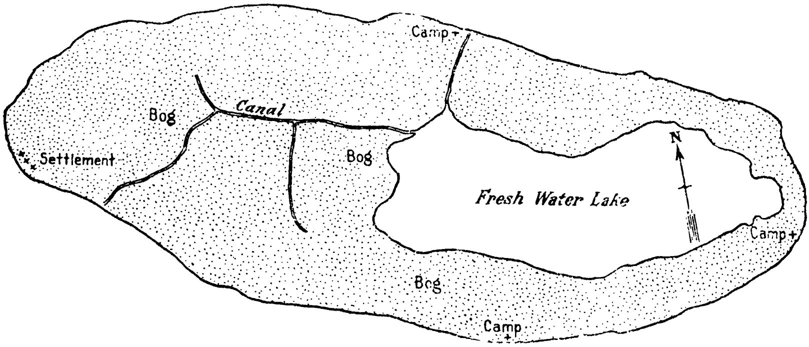


FIG. 2. Washington Island, Pacific Ocean.

Washington Island (fig. 2) is about 4.5 miles long and 1.5 miles wide, with an external circumference of about 10 miles. The central area of the island toward the south end consists of a fresh-water lake about 2 miles long and averaging about half a mile in width. The highest elevation is slightly over 10 feet above mean tide level. The ocean beach is largely sand, thus contrasting markedly with the rather uniformly rough ocean beach of Fanning. The island is traversed by two main canals for drainage purposes as well as for the transport of nuts. There are close to 2,100 acres in coco palms which are practically all wild (not over 200 acres planted), often growing in almost impenetrable thickets of tropical vegetation. Owing largely to lack of cultivation and a greater annual rainfall than at Fan-

ning, thus giving opportunity and impetus for rank growth, Washington Island (Plate 1, fig. 1) gives one the impression that it is much more tropical than is Fanning. The fauna and the flora of the two islands are, however, with few exceptions, very similar.

CLIMATIC DATA

Very few accurate data covering a period of time long enough to estimate fair averages for Fanning Island are available at the office of the company, and practically none at all for Washington. The total rainfall for Fanning during 1918 (to December 20, inclusive) was 102.76 inches, for 1922 it was 59.32 inches, and for 1923 it was 66.41 inches, while for the first eight months of 1924 it was 55.38 inches. The two years for which there is a complete record, namely, 1922 and 1923, are said to have been rather dry years. It is quite probable that the average total annual rainfall of Fanning is between 75 and 80 inches. It is obvious, from general observation and incomplete data, that the average annual rainfall for Washington Island is much greater than that for Fanning. While the months of December to May are said to have a heavier rainfall, the records for Fanning show that the precipitation for July, 1923, was 14.88 inches, the highest recorded for either 1923 or 1922, and January, February, and March of 1923 show 0.32, 0.35, and 0.55 inches. Table 1 shows the precipitation by months, as recorded in the office of the company.

TABLE 1.—*Showing rainfall in inches for Fanning Island by months for the years 1918, 1922, 1923, and 1924 (in part).*

Month.	1918	1922	1923	1924
January	0.72	2.17	0.32	14.17
February	1.71	7.07	0.35	9.16
March	2.63	5.58	0.55	7.90
April	4.38	11.22	5.49	11.01
May	7.23	13.47	8.90	3.27
June	19.70	9.50	6.15	2.52
July	15.36	4.06	14.88	2.98
August	10.60	.56	4.86	4.37
September	10.92	1.25	5.94	--------
October	10.06	.12	4.73	--------
November	4.41	.71	4.89	--------
December	[a] 15.04	3.61	9.35	--------
Total	102.76	59.32	66.41	--------

[a] To December 20, inclusive.

The temperature for Fanning Island, due to trade winds and ocean influence, is remarkably equable, and the daily temperature curve usually shows a striking similarity from day to day (fig. 3). With the thermograph placed at a south window opening of the laboratory and fully protected by a close-fitting canvas curtain over the opening, the temperature during the time of our stay (May to July, inclusive) stood at about 80° F. from about 7 o'clock at night to about 7 o'clock in the morning with a slight downward variation of a degree or two, when it began to rise, approaching 85° F. at about 9 o'clock and remaining near this point with slight deviation until about 4 o'clock in the afternoon when it began to decline (see fig. 3). Deviation from this general daily performance is illustrated by a consecutive twenty-four-hour period when the curve ranged between 76 and 79° F., during which time there was almost continuous rain and high humidity. The office records show a rare maximum temperature of 93° F. and a minimum, equally rare, of 70° F. The annual mean temperature is slightly in excess of 81° F.

The temperature as recorded at Washington Island (no thermograph used) during the very few days of our stay showed little difference from that at Fanning. Nevertheless, the bush, away from the immediate ocean breeze, presents a tropical and humid atmosphere, due to the density of the tall vegetation which is given impetus by the great amount of moisture in the soil, considerable areas of which are veritable bogs difficult to traverse. The actual temperature at Washington at 5.50 p. m. on May 13, 1924, was 78° F.; at 8.30 a. m., May 14, it was 80.5°; at 7.30 a. m., May 15, it was 79°; and at 7.30 a. m., May 16, it was 80°. The thermograph record for Fanning Island at the same time shows almost identical temperatures except for May 13, when it was cooler at Washington, owing no doubt to the rainy weather at the time.

The maximum and minimum temperatures as recorded for Fanning Island in the company's office are shown in Table 2. For this table I used only the monthly maximum and minimum for the purpose of this paper.

The relative humidity of Fanning as measured by the sling psychrometer ranged from 72 to 76, inclusive, during the months of May to July, inclusive. The range for Washington during our brief stay there was 71 to 77, inclusive.

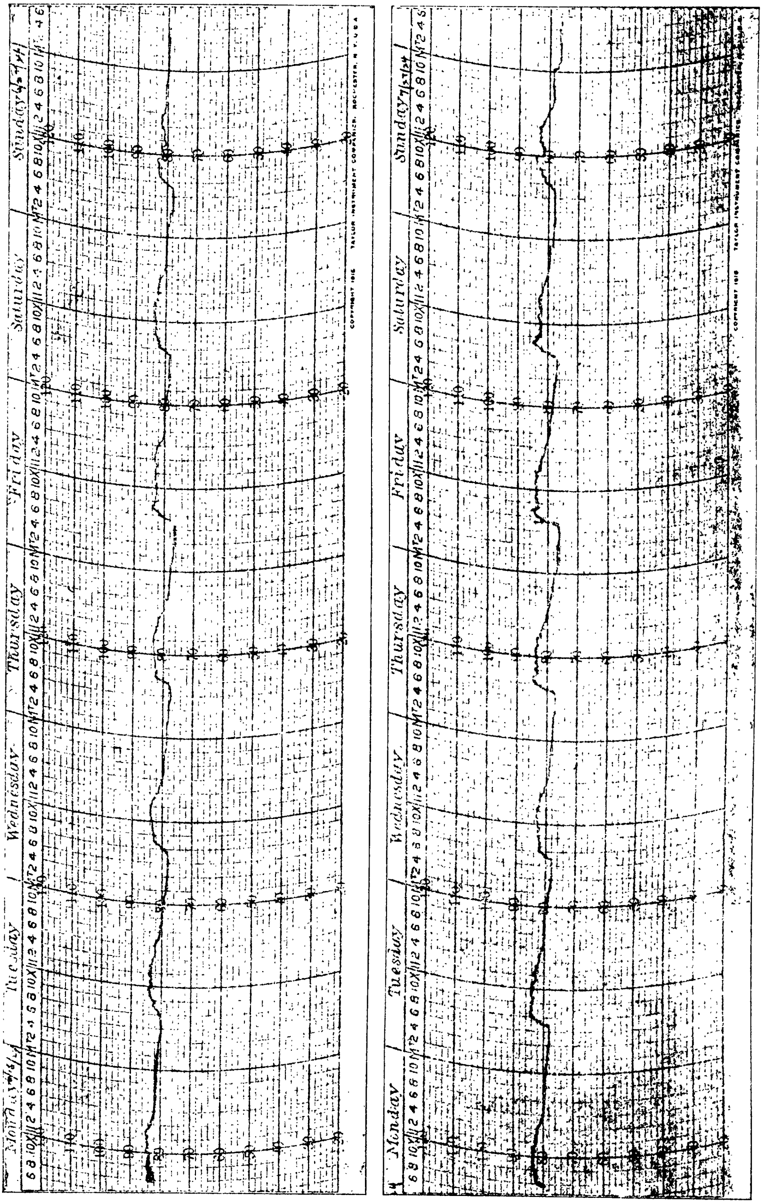


FIG. 3. Thermograph records from Fanning Island for two weeks, showing remarkable daily uniformity.

TABLE 2.—*Showing monthly maximum and minimum temperatures in degrees Fahrenheit, for Fanning Island, as recorded in the office of the company.*

Month.	1918		1922		1923		1924	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January	89	72	87	74	84	73	90	72
February	89	72	86	72	85	75	86	71
March	89	72	86	74	86	75	88	70
April	91	74	85	74	86	74	90	70
May	91	73	86	73	88	74	90	70
June	91	73	86	74	90	73	90	70
July	91	73	85	74	89	74	--------	--------
August	93	73	85	72	86	74	90	70
September	90	73	88	75	86	75	--------	--------
October	90	73	88	74	89	76	--------	--------
November	93	73	86	73	86	74	--------	--------
December	93	74	83	74	84	74	--------	--------

VEGETATION IN GENERAL

Coco palms constitute the dominant vegetation on both Fanning and Washington Islands. While the flora of Fanning Island is typically tropical in nature, it is not so dense as one might expect, though in many places the "bush" is almost impenetrable. These thickets, mainly skirting the ocean shore, consist largely of umbrella, or tahuna (*Tournefortia argentea* Linn. f.), which farther inland often reaches the proportions of fine trees, 40 to 50 feet in height. Nashu (*Scaevola frutescens* Krause) is a densely growing shrub forming part of the thicket, reaching a height of 10 to 15 feet; it is vinelike and difficult to penetrate. Buka (*Pisonia grandis* R. Br.), also much in evidence as a part of the bush, is known as "the wood that grows," since posts made of this wood when placed in the ground soon grow abundant, bright green foliage. Pandanus, or screw pine (*Pandanus* sp.), grows abundantly on Washington Island and less so on Fanning. The strong, often tall and symmetrical trunks are used for rough construction purposes, native huts, etc. The papaya (*Carica papaya* Linn.) is fairly abundant on both islands, particularly Fanning, and bears profusely. Bananas are also fairly abundant and do very well. Near the Main Passage on Fanning there are several splendid breadfruit trees, limes, and mangoes. Ferns (*Polypodium scolopendrium* Burm. f. and *Asplenium nidus* Linn.) and an aroid (*Cyrtosperma chamissonis* Merr.) grow to immense size on Washington and form a prom-

inent part of the vegetation there, but are either absent or inconspicuous on Fanning. A more-detailed account of the flora of these two islands will be published at a later date.

GENERAL CONDITION OF PLANTATION ON FANNING ISLAND

A visit to the various camps on the island and a general view of the neighboring bush give one a fairly favorable impression so far as the general health of the trees is concerned, although there is evidence of neglect in past years, notably in the territory from 1.5 to 3 miles southerly from the Settlement where the trees have been badly handicapped. Here great quantities of brush have recently been cut from between the trees and are now lying piled in great, long heaps, to be burned later. The difference between the growth of trees planted in areas fully cleared and that of trees in only partly cleared areas which have in time become badly choked up is shown in Plate 2, fig. 1; many of the trees shown, at the age of 8 to 9 years, are far behind those of 2.5 to 4 years, shown in Plate 2, fig. 2.

Collections of rubbish (old fronds, husks, brush, etc.) such as one sees in many parts of the island produce very favorable breeding places for rats, which are abundant on the island and, if such pests as the rhinoceros beetle (for example, *Oryctes rhinoceros* Linn.) and other species which breed in rubbish, should unfortunately be introduced, most convenient harborage and protection would at once be available. Furthermore, such collections of rubbish easily conceal intruders until, perhaps, they have become permanently established.

Not only does this rubbish lie for months as a menace, and apparently much of it has already lain for years, but the final disposal of it by burning (which has been done in some places) presents another problem of some importance; namely, many of the young trees become charred in the process and consequently suffer retardation. To drag this enormous quantity of brush to a location free from coco palms, there to be burned, would entail prohibitive expense; hence it must either lie and rot or be burned in situ. To let it lie would prevent necessary sanitation and retard future nutting; hence the other alternative, burning, has already been pursued, in spite of the fact that some retardation must result and some young trees will be lost. Plate 2, fig. 3, illustrates the result of indiscreet burning. If care is exercised (see Plate 3, fig. 1), the damage caused to young trees by fire can be reduced to a minimum. The recovery of certain endogenous plants, particularly the coco palm,

from severe fire injury is very remarkable, and burning of this rubbish can be readily accomplished if judgment is exercised as to wind. Obviously, the proper procedure is to clear the land thoroughly before planting, thus eliminating the problem just described, provided general sanitation of the plantation is continuously practiced thereafter. This will certainly be less expensive in the long run and the good results from healthy trees, unrestricted by choking brush and later by charring flames, emphasizes the correctness of this procedure, not to mention the elimination of nesting places and harborage for certain pests. It would appear practical to leave spaces here and there at certain intervals where rubbish can be carried and burned from time to time without menacing the trees.

A rapid, superficial inspection of many hundreds of trees, covering more than 3,000 acres, would naturally bring one into contact with a number of diseased and dead trees, due to various causes (soil conditions, injury, pests, etc.), for certainly it would be rather remarkable if every planted or wild tree should have survived the ordinary vicissitudes of existence over a period of years. Thus, the total annual morbidity and mortality of a very large city in actual numbers appears to be very great when compared with those of a small town, but when reduced to a percentage basis the situation is not alarming. I do not believe that the percentage of dead and dying trees on Fanning Island would be at all alarming, but when a very careful inspection of each tree in a given area is made and a high percentage of infection is found, then thought should be given to the future, not only to forestall if possible an unduly high death rate, but more particularly to prevent a reduction in the quantity and quality of the fruit.

Shortly after our arrival a careful inspection was made of many individual trees in certain areas on Fanning Island. In one of these areas between 1.5 and 2 miles southerly from the settlement, two hundred seventeen young trees, approximately 2 to 10 years of age, were examined; one hundred thirty-nine, or 64 per cent, of these showed in some degree the work of *Diocalandra taitensis* (Guerin); eight trees, or 4 per cent, were in a dying condition, due to a combination of beetle and caterpillar attack. Of the total number of trees examined forty-eight were rather too young to show the effect of *Diocalandra,* for it appears that this insect does not readily attack the trees until they are somewhere near 3 to 4 years of age; hence, if these young trees are not counted in the total (217), the percentage

of infection among the susceptible trees would be very high, namely, 82 per cent. This percentage of infection corresponds very well with the estimated amount of infection in certain areas between the Cable Station and Napunaiaroa. This high rate of *Diocalandra* infection is not necessarily cause for great alarm, since the damage in many cases is rather neglible, as will be explained later.

While the heaviest beetle infestations are to be found between the Cable Station and Napunaiaroa and near English Harbour (from the Main Passage southerly for about 3 miles), in both of which localities the "white" scale (see later pages) is also rather abundant, the least infestation is noticeable in the neighborhoods of Aua and Tarafefe, particularly Aua. At Tarafefe there is more or less infestation of the younger planted trees in the immediate vicinity of the camp. Toward Rapa Passage southerly from Tarafefe the trees are practically all wild and fairly old. There is, however, not a little of the white scale present in this area. Fareturaina has a slightly heavier infestation near the camp, but in general the young trees in that vicinity are in very good condition. The Tabonañ district is separated from the Cable Station by an extensive thicket nearly 2 miles in length consisting of umbrella, *Pandanus*, and buka. In the immediate vicinity of Tabonañ camp the infestation of *Diocalandra* is rather markedly a trunk infestation, though other parts of the trees are infested, as in other localities. In general, this district shows much less infestation than either near Napunaiaroa or English Harbour and more than either Fareturaina, Tarafefe, or Aua. Notwithstanding the fact that this area contains many more trees at the age when this infection should show most if present, the general thrifty condition of the trees is evident. A few dead or unthrifty young trees show evidence of severe caterpillar (see later pages) infestation, and several older trees appear to have had the tops badly charred, possibly by lightning. Rats are certainly abundant in this area and are responsible for some damage to the spikes and young coconuts.

PESTS IN GENERAL

Rats (*Epimys alexandrinus*).—Rats are to be found practically everywhere on the plantation, and they present a problem which deserves careful attention. The very considerable quantity of rubbish in most parts of the island affords excellent breeding places, as evidenced by nests with young rats in old coco

stumps, fallen and decaying trees, etc. The tops of many trees are literally inhabited by rats, due very largely to the accumulation of dead fronds, inflorescences, etc., which provide good nesting material and a safe harborage. The damage done by rats is partly shown in Plate 3, fig. 2, and many young nuts on the trees show similar treatment. Furthermore, these pestiferous creatures have also the habit of gnawing at the bases of the individual spikelets, causing young nuts to die and fall or, when done very early, causing the female flower to drop off. Frequently every spikelet on a flower stalk shows such rat gnawings, and complete barrenness results. The difference in quantity of fruit produced when a tree is treated for rats was well shown in several old trees at Aua, which prior to this treatment were said to be quite barren. The tops of these trees had been cleaned out, fronds interlacing with fronds of other untreated trees were cleared, low hanging fronds were trimmed or removed, and a tin band (gasoline tin) was placed near the base of each tree, with the result that when we saw these trees they were well laden with fine nuts. Rats on the island could certainly be considerably reduced, and I believe with profit, by a combination of methods judiciously applied; namely, ratproofing as above described, in certain cases only; sanitation, removal of débris by burning; and rat poisoning, by the use of barium carbonate, one part to eight parts of oatmeal mixed with water into a stiff dough and placed in rat runways.

Coconut crabs (*Birgus latro* Herbst).—Coconut crabs (Plate 8), while still to be found on Washington Island, are almost extinct on Fanning Island; hence, they are not a factor in pest-control operations.

Scale insects.—Scale insects are represented principally by *Hemichionaspis aspidistrae* Signoret (Plate 1, fig. 2), which occurs in all parts of Fanning Island and is abundant in places, notably between the Cable Station and Napunaiaroa. This scale attacks all parts (except roots) of both young and old trees. Ripe nuts in husk in certain badly infested trees are sometimes almost white due to the presence of countless numbers of the white male scales. Although at present it is neither abundant enough nor sufficiently damaging to require the specific employment of control measures, this scale insect should nevertheless be kept under surveillance. Many of the scales, both male and female, are parasitized by *Aspidiotiphagus citrinus* (Craw.) but not abundantly as suggested for this scale in other places

by Doane;[2] however, it is quite probable that the parasite will increase rather than decrease and it is likely that it will hold the scale in check. The scale occurs also on several species of weeds and shrubs, in agreement with Doane's observations elsewhere.

Mealy bugs.—Mealy bugs (probably *Pseudococcus pandani* Ckll., which occurs on coconuts in many of the South Sea islands) are fairly widely distributed, though not abundant enough to cause any anxiety at this time. It is true, however, that this species is nevertheless responsible for considerable damage in other localities.

Caterpillars.—Damage by caterpillars was observed in many parts of the island, and very young trees are rapidly killed when these insects feed on the tender young cabbage. Should many young nursery trees be set out, these insects would, no doubt, prove a source of some worry, since they are well concealed within the folds of the young leaflets, and cannot be reached with ordinary spray materials. The younger leaflets soon turn yellow and die, the older leaflets become crinkled, and the entire frond finally presents a much-contorted appearance (Plate 5, fig. 1). The young trees thus infected are usually badly twisted and present a very ragged, almost charred appearance. Not only are the larvæ well concealed within the folds of the leaflets (underside), but also they spin a very delicate, protective web, within which, when disturbed, the larva retreats with remarkable speed. The full-grown larvæ measure about one inch in length and spin rather tight-spun white cocoons. I do not know how long the larva requires to reach full growth, but the pupal period requires but six or seven days. The newly emerged moth is of a very beautiful shining lemon color. The species remains unidentified.

Coconut beetles.—Beetles belonging to two species [*Sessinia (Anaca) collaris* (Sharp), dark in color, and *Sessinia (Anaca) decolor* (Fabricius), light brown] each about a half inch in length, in about equal numbers, are generally distributed over the island and fairly swarm over the male flowers of newly expanded inflorescences. The beetles thrust their heads eagerly into the flowers and feed upon the pollen. Newly opened inflorescences generally present a very lively picture with literally dozens of these beetles most eagerly at work, and several small

[2] Journ. Econ. Ent. 2 (1919) 220–223.

lizards of two species licking in most satisfied fashion the surfaces of the not yet open female flowers and, added to these, ants crawling busily over all. Although honey bees are plentiful on Fanning Island, they do not frequent the inflorescences to any marked degree. It should be stated here that too intimate contact with the "coconut beetles" is not advisable, since severe blistering will surely result. The darker species [*Sessinia* (*Anaca*) *collaris* (Sharp)], at least, probably breeds in rotting wood, since one of us collected a pupa in rotting umbrella wood. It is unlikely that these voracious beetles actually cause serious reduction in the amount of pollen.

Bud rot.—Since bud rot is widely distributed, practically throughout the Tropics, and is generally regarded as a serious menace to the coconut industry, evidences of its presence on Fanning Island were immediately sought. Johnston[3] describes the disease as follows:

> The common name of the disease, bud rot, well describes its nature, for in its acute or advanced stages the bud of the tree, i. e., the growing point in the center of the crown, is affected by a vile-smelling soft rot which destroys all the younger tissues. At this stage most of the nuts have fallen, the lower leaves are turning yellow, and the middle folded and undeveloped leaves are dead and hang down between the still green surrounding leaves. Signs of the disease in its incipiency are (1) the falling of the immature nuts; (2) a staining of the opening flower spikes, partly or wholly, to a rich chocolate brown; and (3) the dying and bending over of the middle undeveloped leaves. When the nuts are being shed investigation reveals at the base of the affected spikes a dark-colored wet rot which spreads around the leaf sheaths, or strainers, as they are locally (Cuba) known. This rot appears as water-soaked areas which may reach a length of 15 or 20 centimeters on both the upper and lower surfaces of the bases of the leaves. This condition often penetrates the leaf bases to a depth of 2 centimeters or more, and the tissues involved in it swarm with bacteria. As the white tissues at the base of the leaf become old and green the water-soaked spots harden, and they may often be found in this condition on otherwise perfectly healthy trees * * *. The rot spreads from the base of one spike to another through the wet strainer. It is probable that insects carry the disease from one part to another since there may be one or more points of infection. Gradually all the spikes become affected and shed their nuts, and the leafstalks become so rotted at their bases that they are not able to maintain their natural position, but are pendent, often for a long time, or else fall off.
>
> If the infection starts in the central leaves the disease is apt to progress rapidly downward into the younger tissues, which it is very active in disintegrating, the vascular bundles being so soft as to allow the tissues to go entirely to pieces. In the center it may progress into the

[3] U. S. Dept. Agr. Bur. Plant Industry Bull. 228 (1912) 1–175.

trunk for a short distance and rot out the fundamental tissue leaving only the fibers which are too hard to be disintegrated. This rot has been found, exceptionally, as far as 1.5 meters under the heart of the bud, a hard outer shell being left around the central rotted portion. Usually the decay extends in the trunk under the bud for a distance of only 0.2 to 0.5 meters and never throughout its length * * *. The spread of this disease may be very rapid. It may occur year after year as only scattered cases in a grove, but frequently whole plantations may be affected in a short time. In such groves scores and scores of bare trunks may be seen, the crowns of which have rotted and blown off. There may be trees with the whole crown bent over and hanging downward, and others with three or four ragged leaves waving upright in the air and all the rest brown, broken, hanging down, and dead. In the midst of this desolation there are often some green-crowned trees retaining a few nuts, or still in good bearing. From two months to more than a year may elapse from the time of the infection of the tree to its destruction.

Trees that gave any appearance whatsoever of bud-rot symptoms were carefully examined; and, although no bacteriological examination was made, owing to lack of facilities, I believe it fairly safe to state that this disease has not made its appearance on Fanning Island. The above description of the disease should be of assistance in detecting its presence, and should it be found strenuous efforts should, of course, be put forth to curb it without delay. The following recommendations by Johnston (loc. cit.) will, no doubt, be of service. He states:

It is recommended, therefore, to cut down all badly diseased trees, at least trim the tops and set fire to them. All debris, fallen leaves, nuts, etc., should be removed so as to destroy any infected material and any breeding places for insects which might serve to transmit the disease * * *. These ordinary methods of sanitation, together with proper methods of cultivation, if carried out faithfully by the planters of a whole district, will reduce the loss by this disease to a minimum.

Sundry insects.—Many species of insects are more or less closely associated with the coco tree and the copra industry. A slender, coal-black weevil, *Oxydema fusiforme* Woll., measuring about a quarter of an inch in length, frequently occurs under the leaf sheaths, or "strainers," or in decaying splits, etc. So-called copra "bugs" (beetles), *Necrobia rufipes* Fabr., occur in vast numbers about the copra house and in neighboring buildings. The larvæ of these beetles breed as a rule in the old copra waste, but may also breed in the copra waiting to be shipped and may then cause some damage which, however, is usually regarded as slight. Several species of ants occur in great numbers on the trees. Old fallen nuts, particularly on Washington Island,

show numerous emergence holes of the shot-hole borer *Xyleborus confusus* Eich.

Diocalandra taitensis (Guerin), with which this report chiefly deals, is undoubtedly the most important pest attacking the coco palm on Fanning Island. The identity of this insect, which had been causing much concern to the owners of the island, was established the day following our arrival at English Harbour. Typical injury to the trees and the discovery of larvæ and adults at work proved the insect to be *Diocalandra taitensis* (Guerin), Plate 4, fig. 1, as previously reported in a letter by me to Mr. D. B. Crane, under date of January 21, 1924, in part as follows:

> * * * as you have stated in your proposed cablegram, the specimens are not *Rhyncophorus ferrugineus* Fabr., but *Calandra taitensis* Guerin * * *. The Calandra beetles (weevils), on the other hand, as identified from specimens submitted, require different treatment * * *. Just what method of control to use seems to me somewhat doubtful without more careful study of the life history and habits of the insect and other possible plant hosts.

This beetle enjoys a rather wide distribution among the islands of the South Seas. It was first described from Tahiti in 1840, by Guerin.[4] Swezey[5] (1920) reports one specimen of this species in a collection from Tutuila, Samoa, and he also reports its presence on the whole leeward coast of the Island of Hawaii. Concerning the work of this species, Swezey[6] states:

> Its larvæ feed in the edges of the lower part of the leaf stalk, and as it is the older leaves that are most often attacked, they are not significantly injurious to the trees. They, too, are likely to be more abundant in stubs of cut-off leaves.

Doane[7] made a study of the larval work of this species in the Society Islands, where he evidently considers it a more or less serious pest. He states:

> A still more serious damage is done where the larvæ attack the spikelets, killing them at the point of attack and working toward the base.

Specimens of this species were taken on Christmas Island, August 1 to 3, 1924, by Mr. Kirby, who has reported to me that the species is as abundant there as on Fanning, if not more so. Dr. L. S. Harrison, who accompanied the recruit-

[4] Iconographie du regne animal. Paris (1840) 171.
[5] Proc. Hawaiian Ent. Soc. 6 (1920) 333–335.
[6] Proc. Hawaiian Ent. Soc. 5 (1924) 385–393.
[7] Journ. Econ. Ent. 2 (1919) 220–223.

ing expedition to the Gilberts during the summer of 1924, reports the presence of this beetle (in June) on Abaiang Island, where he states it is fairly abundant. A very closely related species, *Diocalandra frumenti* F., also known as the "four-spotted coconut weevil" of the Philippine Islands (where it is common, as well as in the entire Indo-Malay region), although strikingly similar to *D. taitensis* in form, color, and size, is said by Banks [8] to occur "in the dead or decayed heart or the undeveloped leaves" and to attack "only dead trees of a very small size" and "found only in locations where others have preceded them and killed the trees; hence they are not in any sense a menace to the healthy tree." Mr. W. Schultze, of the Bureau of Science, Manila, in a letter to me under date of April 21, 1925, states, "It is mostly found on coconut, but a few times I have found it on sugar cane, on newly cut ratoon stools."

The isolation of Fanning and Washington Islands, particularly the latter, no doubt made these among the latest to become infested with *Diocalandra taitensis*. The introduction of this pest may, perhaps, be explained through the recruiting of labor from other islands where the beetle may have occurred for many years. Natives frequently take coconuts with them as food and drink on recruiting voyages; the nuts, together with mats and other articles made from fronds and other parts of the coco tree, might easily account for the introduction of the species, either as beetle or as grub. I observed this possibility during the process of loading the *Doris Crane* for a recent recruiting voyage, natives returning to the Gilberts having articles with them which might easily give ample opportunity for such transfer. In view of the fact that Fanning Island still enjoys freedom from many other serious pests, it would seem most desirable to exercise due precaution in recruiting enterprises.

The fact that the beetle is most abundant at English Harbour and near the Cable Station lends weight to our belief that it was first introduced at these points where contact with the outside world is made. Just how long the species has existed on this island is practically impossible to determine, but it has probably been here for at least eight or ten years, perhaps much longer. Aua and Tarafefe, the more remote camps, appear to have the least infestation. That the presence of the beetle was not even suspected until its discovery quite recently is due largely to the rather slow and subtle nature of the work of the insect and also

[8] Philip. Journ. Sci. 1 (1906) 143–167, pl. 1–10.

to the lack of careful inspection, no doubt thought to be unnecessary because of the general healthy appearance of the trees and the isolation of the island. These several factors combined enabled the beetle to gain a firm foothold before it was discovered. Furthermore, conditions now known to be due to the beetle larvæ were attributed to other causes, or else no explanation for the injury was attempted.

NATURE OF DAMAGE

The larva of *Diocalandra taitensis* (Guerin) is a typical borer, and enters the healthy tissue of the coco palm (apparently its only host plant), where it grows rather slowly, frequently burrowing from 1 to 1.5 inches deep into heavy fronds and often tunneling (very slowly) a distance of 5 to 6 inches before coming to rest for pupation near the surface or at a crevice produced by splitting or hacking. The position of the older larvæ is marked by twisted strings of dark brown frass and castings, by discoloration of the tissue, and exudations from the plant (Plate 7, fig. 1). When the larva tunnels near the surface of the frond or base of a spike its course can be traced by the blackened plant tissue. Infection of the frond is usually located along the edges of the midrib and at the base, frequently at the basal connection with the trunk and, less frequently, at the axils of the leaflets, when the frond soon presents a very ragged appearance, the leaflets turning yellow, and fractures result (Plate 5, fig. 2). The larvæ also attack the trunks of older trees from which we frequently took both larvæ and pupæ.

The greatest damage is done when the larvæ attack the spikelets or, more particularly, the base of the spike itself. Spikelets with female flowers or young nuts, when thus attacked, will not mature their fruit and, when the base of the spike is well bored (Plate 7, fig. 2), a total loss of all its nuts is generally certain. Deformed nuts, which soon drop off, will result from *Diocalandra* borings, as shown in Plate 5, fig. 3. Fifteen such deformed and totally worthless nuts on one spike are not infrequent. I have seen many trees which should have been in bearing, many spikes being present, yet they were entirely devoid of nuts, or burdened with deformed nuts, as shown in the figure, which on inspection showed the marks of the borer in every spike examined.

It must, of course, be recognized that the absence of nuts from a spike or the presence of malformed nuts may be the result of other causes as well, such as absence of female flowers,

non-pollenization, rats gnawing at spikelets, nutritional defects, etc.; but it is significant that bare spikes and deformed nuts are remarkably abundant between Napunaiaroa and the Cable Station and in the vicinity of English Harbour where *Diocalandra* is abundant and well established, while at Aua where the pest is uncommon practically no malformed nuts were seen. The latter statement holds good also for the vicinity of Tarafefe. Growers of long experience have expressed perplexity over the fact that often one side or parts of a tree may bear normal nuts while the other side or other parts bear nuts such as shown in the figure. If the trouble were to be found in a general nutritional obstruction then it would follow that all the nuts would be affected and the tree itself should show signs of unthriftiness. So far as our observations on Fanning are concerned, *Diocalandra* borings have generally been present in the spikes bearing either no nuts or bad nuts and either no borings or very slight in the good ones. In Plate 6, figs. 1 and 2, are shown two trees growing within 60 feet of each other, approximately of the same age, and equally thrifty in general appearance; yet, one is laden with nuts and shows no damage to the spikes, while the other is almost devoid of nuts, though spikes are present (all of which, so far as I could examine them, showed *Diocalandra* borings).

Borers also frequently attack very young nuts at the point of attachment, causing them to drop. Husks of older nuts are frequently bored, and I have seen traces of larvæ having burrowed completely through the husk and into the nut. Such attacks generally result in badly deformed nuts or in dehiscence.

As stated earlier in this paper, the borers appear not to attack (or at least to do so rarely) young trees under about 4 years of age, while trees from about 6 to 10 years old seem to suffer most, particularly trees just about beginning to bear. The old trees and their fruit appear to suffer but little damage from borer attack, although the insects are frequently present. I have taken several beetles from between the sheath and the base of badly bored and nutless spikes on a tree 50 feet high.

While I do not believe that *Diocalandra* will directly kill a tree of any age, I have seen trees that were beyond redemption due to a combination of *Diocalandra* and caterpillar attack, resulting in a badly twisted and dwarfed condition (Plate 6, fig. 3). Such trees should be cut down and burned without delay in order to destroy a prolific source or focus of pests, both borers and caterpillars. That young trees are weakened by

Diocalandra borings alone appears to be obvious, and that a marked reduction in nut production often results due to borings in spikes, spikelets, and young nuts is certain.

The burrowing of the borers also paves the way for bacterial and fungous attack which usually augments the damage. Conversely, also, wounds infected with bacteria and fungi offer acceptable points of attack for the beetles. For example, in cutting out larvæ from fronds, a practice quite generally employed, an injury results which quickly leads to a decay of the surrounding tissue, and it is in such situations that beetles may usually be found in due course of time, provided there is a crevice into which the insects can creep. Hence, if this practice is continued, the cut area should be treated immediately with a chemical which has both healing and repellent properties.

METHODS OF COLLECTING BEETLES

Beetles were rather easily collected in sufficient numbers for our purpose from coco palms in various parts of the island, but especially in an area between 1 and 3 miles southerly from English Harbour, where our temporary laboratory was located. In the area just mentioned there are many young bearing trees, and the percentage of *Diocalandra* infection is considerable. Infected trees could always be located easily by means of the dark strings of frass on the fronds, trunk, or other parts of the tree. Partly split, gashed, or otherwise injured fronds showed conspicuous darkened areas and generally served to locate beetles. By opening these split or gashed areas the beetles were exposed, and they were then carefully lifted off by means of forceps and placed in glass vials. The beetles adhere rather tightly to the tissue but when disturbed commonly let go and drop, feigning death. I have never seen them attempt to fly away while working with them in the field, although they crawl rapidly and disappear quickly in even very narrow crevices.

The beetles were taken to the laboratory and placed for breeding purposes in vials or pill boxes, the former being more satisfactory, because observations could be made more readily and eggs recovered more easily. In many instances pairs taken in copulation were placed in separate vials, while in several instances as many as twenty-five were placed in a vial. In each vial was placed a strip of coco-palm wood for the insects to feed upon. These strips were quickly punctured with holes. The vials were numbered and records were kept for each on numbered library cards. Observations were made from three to

four times daily until the death of the beetles. Eggs were found either on the walls of the vials or on the strips of wood, and they were transferred by means of a camel's-hair brush to separate vials and each was given a separate number which was recorded on the card of the parent. When the larvæ hatched they were likewise transferred to a slit in a cross section or block of a young coco frond; each block was about 2.5 inches long, about 1 inch thick, and about 1.5 inches broad. The larvæ generally quickly concealed themselves in these slits and soon began burrowing from sight. The infected coco blocks were numbered to correspond to the number given the egg, and were then placed with other blocks in a fruit jar. In order to observe early developments several larvæ were placed on rather small coco strips from which the grubs could be easily recovered by splitting the strips.

In order to observe pupation practically full-grown larvæ were extracted from infected fronds in the field and transferred to a pit cut into a small block of coco-palm wood. The block with the larva was placed in a vial and the pit covered with another block of coco-palm wood. Generally in an hour, more or less, the grub had covered itself with borings and began burrowing in the block, where eventually it pupated. In order to follow developments it was necessary to split the block every two or three days.

Pupæ were also collected in the field by carefully removing enough of the surrounding wood with a knife so as not to disturb or injure the pupa. The blocks were taken to the laboratory and placed in pill boxes where observations could be readily made. Pupæ removed from the trees without some of the surrounding wood and placed in pill boxes almost invariably died.

Egg.—The eggs are nearly a millimeter in length, slender, and well rounded at both ends (Plate 4, fig. 4). When first laid they are pearly white in appearance, becoming somewhat milky white as incubation proceeds. I have taken the eggs in the field in various situations where the adult beetles found good harborage, a good location being in the crevice of a more or less split coco frond, where decay has already set in, or under the strainer at the base of an old frond, also between the sheath and base of the spike. The eggs are apparently frequently deposited in scattered masses ranging from eleven to thirty-one and, more frequently, singly. The number of eggs deposited by the individual female beetle was not ascertained; however, the

number deposited under experimental conditions in the laboratory was never large, ranging from two to four, even by females newly emerged from the pupa and mated. Presumably the number laid in nature may be represented by the number taken in egg clusters, although that point also is difficult to determine, since the adults frequently occur in groups (as many as ten or twelve) always protected, of course, in a crevice or under the strainer folded over the edges of the frond.

Under temperature conditions already described the incubation period varies from four and a half to eight and a half days. Movements of the embryo can easily be seen through the egg shell twenty-four hours prior to hatching.

Larva.—The newly hatched larvæ are rather active, which enables them to crawl some distance. In laboratory experiments I have found that the larvæ do not readily attack smooth, tough frond tissue, but find lodgment in small cuts or pits produced by the gnawing beetles, which openings they enter and soon begin to burrow. Nevertheless, the heavy, otherwise unblemished base of the coco frond, particularly along the fibrous edges, presents a favorite location for the larvæ, as do the axils of the leaflets. After penetration, growth is very slow and observation then becomes almost impossible. Older larvæ can be cut out from the tree and transferred to small blocks from coco fronds, into which pits are cut with a knife and the larvæ introduced. The larva soon burrows and covers the hole with tiny shreds and continues its development. By placing such a block in a small vial to protect the larva against ants, observations can be made from time to time by splitting open the block to expose the larva for examination and then quickly closing it again to prevent too much disturbance. This method of observation, to be sure, cannot be relied upon to give accurate information relative to rate of larval growth. The time covered by the investigation was not long enough to determine the length of the larval period accurately. From a combination of evidence, both field and laboratory, it would appear that the larval stage requires from eight to ten weeks. Two larvæ that appeared to be about full grown were treated as above described on May 19, 1924, and did not pupate until June 21 and 22, 1924. Opening the block of coco wood at intervals of about three days, no doubt, greatly disturbed the larvæ, as evidenced by the new frass or repaired protective cases produced each time after examination. However, undisturbed checks appeared to

develop with about equal slowness. The full-grown larva (Plate 4, fig. 2) is cream colored and rather plump, and measures from 9 to 10 millimeters in length.

Pupa.—The full-grown larva comes finally to rest in an enlarged burrow near the surface, not necessarily at the surface, which it lines with finely cut borings (frass), producing a crude capsule (Plate 4. fig. 3). In a remarkably short time the larva takes on pupal form, showing the proboscis, appendages, and general outlines of the imago with remarkable clearness (Plate 4, fig. 2). The color of the pupa remains shining white to cream color until about time for emergence, when it darkens somewhat, not really taking on the rusty red markings and general color of the adult until it has actually emerged from its cell. I have taken pupæ from many parts of the coco tree, including particularly the edges of old fronds and axils of leaflets, also from the bases of spikes and spikelets. Ten to twelve days are required for the pupal period. Thus the time required to complete the life history of the species (egg to emergence of imago) appears to be from ten to twelve weeks.

Adult.—The adults are rather easily collected by picking them off the wood by means of fine-pointed forceps. They hold on rather firmly but when disturbed usually roll off, feigning death. They apparently do not normally use their wings, being able to crawl rapidly. I have allowed the beetles to crawl on the table and but rarely have I seen them try their wings and then only with remarkably little success, the insects progressing with a sort of hop and weak use of the wings for but a few inches.

The adults can use their proboscides remarkably well, literally chewing holes through coco strips which were placed in vials to serve as food and as a place for egg attachment. Eggs are frequently deposited in the crevices of the pitted wood, although I have more frequently found the eggs attached to the walls of the glass vials containing the beetles. The beetles remain in one position for hours at a time, gradually chewing a hole (pit) in the strip. The head is rocked from side to side as the insect chews.

Males often engage in a veritable rough-and-tumble conflict, butting each other about like rams for the possession of a female. When paired they may remain in copulation literally for hours at a time. The adult insect is a small, narrow weevil, measuring somewhat over one-quarter inch (7 millimeters) in length. It is pitchy black in ground color with reddish yellow

216702——8

legs; there are clouded markings on the thorax, and the wing covers vary from practically all red to red with six black spots or markings, two basal, two median, and two apical. The head and beak are about half the length of the thorax, or one-fifth the entire length of the insect.

DIOCALANDRA ON WASHINGTON ISLAND

As already stated, the cocos on Washington Island are nearly all wild, and most of them are fairly old, except some planted near headquarters. This planting near headquarters, and as far inland as a large surveyor's block, was inspected for beetle injury both morning and afternoon of the day following our arrival on Washington Island, May 14. My note book record states "*Calandra* work seems to be scarce." Comparatively few trees showed typical frass; very few larvæ and no beetles were found. On the day following (May 15) a trip was made with Major Burn-Callander by boat through the canal to Monouou where such trees were examined as could be reached, and no trace of beetle work was seen at that end of the island. Other trips were made to beyond the northerly end of track, both along the beach and inland, and again few traces of beetle injury could be found. That this beetle has already established itself on Washington Island is certain, but it is at present causing very little or no damage. There is no reason to believe that the life history and habits of the beetles on Washington Island differ from those of Fanning Island; hence, facts ascertained at the latter place should apply with equal force to the former.

CONTROL MEASURES

From the general nature of the coco tree and the habits of the insect pest, it becomes obvious that the usual methods of insect control cannot be employed economically or are totally impracticable. Thus, fumigation as employed in citrus orchards against scale insects is out of the question, and spraying as employed, for example, against the codling moth of apples is almost equally unthinkable. The first suggestion that seems fairly reasonable is the removal of the borers by cutting out infected parts or by elimination of complete fronds. It has already been pointed out that the parts thus injured become very attractive to beetles in time, hence the need of applying a chemical, such as carbolineum, to produce rapid healing of the wound and also to act as a repellent against the insect. This method of control also calls for a further precaution; namely, expeditious destruction of the removed part, because, unless the

removed portion is very small, indeed, thus drying up in short order, the larvæ will continue their development through pupation to emergence of adults. This I have repeatedly observed, particularly where large parts of fronds have been lopped off and either allowed to remain where they had fallen or removed to a heap of rubbish. These parts must be burned within a short time after removal. A month's time will not allow many of the insects to complete their development and will permit a little time for drying.

Frequent systematic inspection of all trees up to 10 or 12 years of age should be practiced, so that badly infested trees may be located and given particular attention; or, if too far gone and a prolific source of pests, which is usually the case, they should be chopped down and burned without delay.

Natural enemies of *Diocalandra* on Fanning Island seem to be entirely absent, at least so far as our observations are concerned. In our breeding and life-history experiments hundreds of beetles, numerous pupæ and larvæ, and many eggs were kept for adequately long periods in vials, pill boxes, fruit jars, and other receptacles, and always a careful watch was kept for parasites, but none was observed. Because of the difficulty in controlling this species by so-called artificial means, biological control through the agency of natural enemies seems particularly desirable. This method of control is successfully practiced in parts of California against certain citrus pests, notably the soft brown scale (*Coccus hesperidum* Linn.), which is controlled by means of certain species of very tiny wasps (*Aphycus* sp.), and the cottony cushion scale (*Icerya purchasi* Mask.), controlled by its natural enemies, the ladybird beetles [*Novius cardinalis* (Muls.) and *N. koebelei* (Olliff)].

In the introduction of pests to a new locality, entrance is frequently made without their natural controlling factor that makes the same species comparatively or quite innocuous in their native habitat. The United States Department of Agriculture through its Bureau of Entomology has entomologists stationed in Japan at present, in order to find a parasite to combat the destructive Japanese beetle (*Popillia japonica* Newn.) which, while of little consequence in Japan, is most damaging in an ever-increasing area in the eastern United States. This investigation I am informed is giving very hopeful results. Thus it would appear that *Diocalandra taitensis* (Guerin) must exist somewhere under conditions where it is held in check by its natural enemies; these might perhaps be reared

in sufficient quantities to be introduced on both Fanning and Washington Islands and, by gaining a foothold there, would eventually bring the beetle pest under practical control.

SUMMARY

1. Both Fanning and Washington Islands are so situated geographically and commercially that it should be difficult for pests to gain entrance except through the company's own transportation and infrequent steamer communication (by lighter and launch) at the Pacific Cable Station at Fanning. With the increasing necessity for precaution in the face of the growing importance of pests, greater care is urged in inspecting cargo, particularly that from the South Seas (inclusive of the personal effects of recruited laborers), in order to forestall further introduction of pests and diseases of the coco palm to these islands, which are even yet free from many of the worst pests that have fairly ravished many plantations in other parts of the world. In this matter the Pacific Cable Board would without question render hearty coöperation.

2. The total annual rainfall for Fanning Island is indicated by the records for the following years: 1918 (to December 20), 102.76 inches; 1922, 59.32 inches; 1923, 66.41 inches; and for the first eight months of 1924, 55.38 inches. Although June to October are regarded as the drier months, the rains are fairly evenly distributed during the year. While Fanning Island lies on the edge of a rain belt, Washington Island is nearer the middle of this belt and consequently enjoys a heavier rainfall. The temperature on Fanning Island is remarkably equable throughout the year, the maximum being 93° F., which is rarely reached, 85° F. being the usual maximum, while 70° F. is the minimum, which also is rarely reached, 78° F. being the usual minimum. Cooling trade winds play an important part in making these islands fairly comfortable. The temperature of Washington Island is much the same as that of Fanning, but with its heavier rainfall and vegetation it presents a much more tropical atmosphere. The relative humidity of Fanning Island ranged from 72 to 76, inclusive, during the months of May to July, the period of our stay. Washington Island humidity readings on four days during May ranged from 71 to 77, inclusive.

3. The coco plantations of Fanning Island comprise about 3,200 acres, of which about one-third is in wild trees. The trees in general present a fairly healthy appearance, although many of them of bearing age in certain localities have not begun

to bear owing to extreme retardation by choking umbrella, buka, and nashu brush, now largely cut and piled waiting to be burned; while other trees, though thrifty in appearance, bear many deformed nuts or shed them while still young. Collections of rubbish are conspicuously present in some parts of the island, and these afford a most favorable harborage for rats and other vermin and would certainly prove disadvantageous should certain other pests which breed in decaying rubbish and not now present be unfortunately introduced. This defect is being rapidly remedied.

4. The Washington Island plantation (uncultivated for about one and a half years) comprises about 2,100 acres of coco trees, of which about 200 acres are planted. The wild trees have grown up entirely too close together, and there are sprouting nuts, much tangled and rank undergrowth, and bog in many places, all of which present nutting and other difficulties of some importance, though not within the scope of this investigation.

5. Burning piles of brush among the rows of trees, while unavoidable, has resulted in severe temporary injury to many young trees; however, with relatively few exceptions, these have revived. Removal of brush from among the badly choked trees was imperative and, in order to carry out ordinary plantation sanitation and eliminate future nutting difficulties, destruction of this brush by fire is necessary; to drag the brush to free areas there to be burned would entail prohibitive expense. Great care and judgment must be exercised in burning the brush. Future methods of planting and cultivation will, of course, be guided by past error in judgment.

6. Pests of the coco palm on Fanning and Washington Islands are rats (*Epimys alexandrinus*), which gnaw young nuts and the bases of spikelets; robber crabs (*Birgus latro*), almost extinct on Fanning; white scale (*Hemichionaspis aspidistrae*), well parasitized by *Aspidiotiphagus citrinus;* mealy bugs (*Pseudococcus pandani*), not abundant; caterpillars, belonging to two species not identified, particularly damaging to very young trees; *Xyleborus confusus,* a shot-hole borer, in old fallen nuts in particular; and the lesser coconut borer (*Diocalandra taitensis*), the most important of all.

7. The larva of *Diocalandra taitensis* bores into the healthy plant tissue, attacking fronds, trunks, spikes, spikelets, and young nuts. Trees from about 3 years of age to very old ones are attacked by the beetles, the greatest amount of damage being done to trees which have recently come into bearing,

and here the damage consists primarily in the loss of nuts through bored spikes and spikelets. A combined *Diocalandra* and caterpillar attack will cause young trees to become badly twisted and stunted, and death may ensue.

8. The beetle lays its eggs in crevices in split or otherwise injured fronds, or between the strainer and the edge of the frond, and between the sheath and the base of the spike. Although only from two to five eggs are deposited by the female beetle in the laboratory, egg masses of eleven to thirty-one eggs have been taken in the field, but in the presence of groups of females. The incubation period is from four and one-half to eight and one-half days. The young borers are very active and are soon lost from sight, as they burrow into slight abrasions or among the hairs of the fronds or, in fact, almost any place that offers a favorable point of entrance. There is a marked preference for healthy tissue.

9. Based on cumulative fragmentary evidence, both in the field and in the laboratory, it appears reasonably certain that the larval period requires from eight to ten weeks, by the end of which time the full-grown larva has burrowed fairly close to the surface where the plant tissue has by this time become fairly well decayed by the working of the larva, and there it constructs a crude case of castings and borings and then pupates.

10. The pupal period can be rather easily ascertained by allowing larvæ to pupate in small blocks of coco wood in the laboratory. From ten to twelve days are required to complete this period. Thus the entire life history of *Diocalandra taitensis* requires approximately from ten to twelve weeks.

11. That it would be easy to transport this species long distances is evidenced by the fact that, on May 19, a well-advanced larva was placed in a block of coco-palm wood measuring about a half inch square; it pupated in this same piece June 22, and emerged as an adult beetle on July 3. In the meantime, in order to observe developments, the block had been split open numerous times and afterward tied together again with thread. Another similar experiment, conducted simultaneously, gave like results.

12. The usual methods of insect control cannot be applied economically. Frequent inspection of all trees up to 10 or 12 years of age is strongly recommended. Badly infested young trees (3 to 5 years of age), if twisted and dwarfed, form a center of distribution, and they should be cut down and burned without delay. Badly infested fronds should be cut and burned;

the remaining cut portion should be treated with an effective healing and repellent chemical.

13. The beetle infestation on Washington Island is comparatively light and, with the exercise of good judgment in the application of control measures, might be rather easily prevented from spreading and perhaps wholly smothered.

14. It is strongly recommended that a determined effort be made to locate a parasite that will prey effectively on *Diocalandra taitensis,* preferably on either the egg or the adult.

ILLUSTRATIONS

PLATE 7

FIG. 1. Larval borings of *Diocalandra taitensis* (Guerin) in midrib of fronds. Note frass and discoloration.

2. Segments near base of coconut spikes showing borings of larval *Diocalandra*. This damage to the spike when bearing young nuts prevents proper nourishment and results in deformed fruit and dropping.

PLATE 8

The coconut crab, *Birgus latro* Herbst, showing enormous size of powerful pincers.

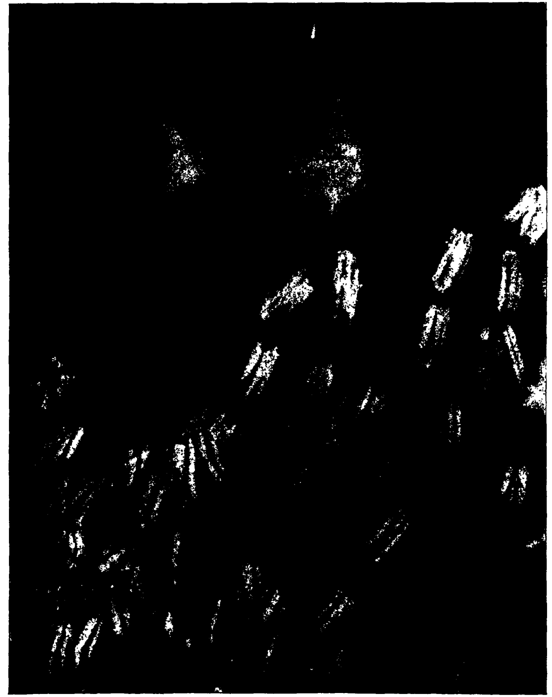
TEXT FIGURES

FIG. 1. Map of Fanning Island, Pacific Ocean; 3° 51′ 26″ north, 159° 22′ west. (Drawn by Robt. O'Neal, Honolulu.)

2. Map of Washington Island, Pacific Ocean; 4° 41′ 10″ north, 160° 19′ west. (Drawn by Robt. O'Neal, Honolulu.)

3. Thermograph records from Fanning Island for two weeks, June 16 to 22, inclusive, and July 21 to 27, inclusive, 1924, showing remarkable daily uniformity.

1



2

PLATE 1.

1

2

3

PLATE 2.

1

2

PLATE 3.

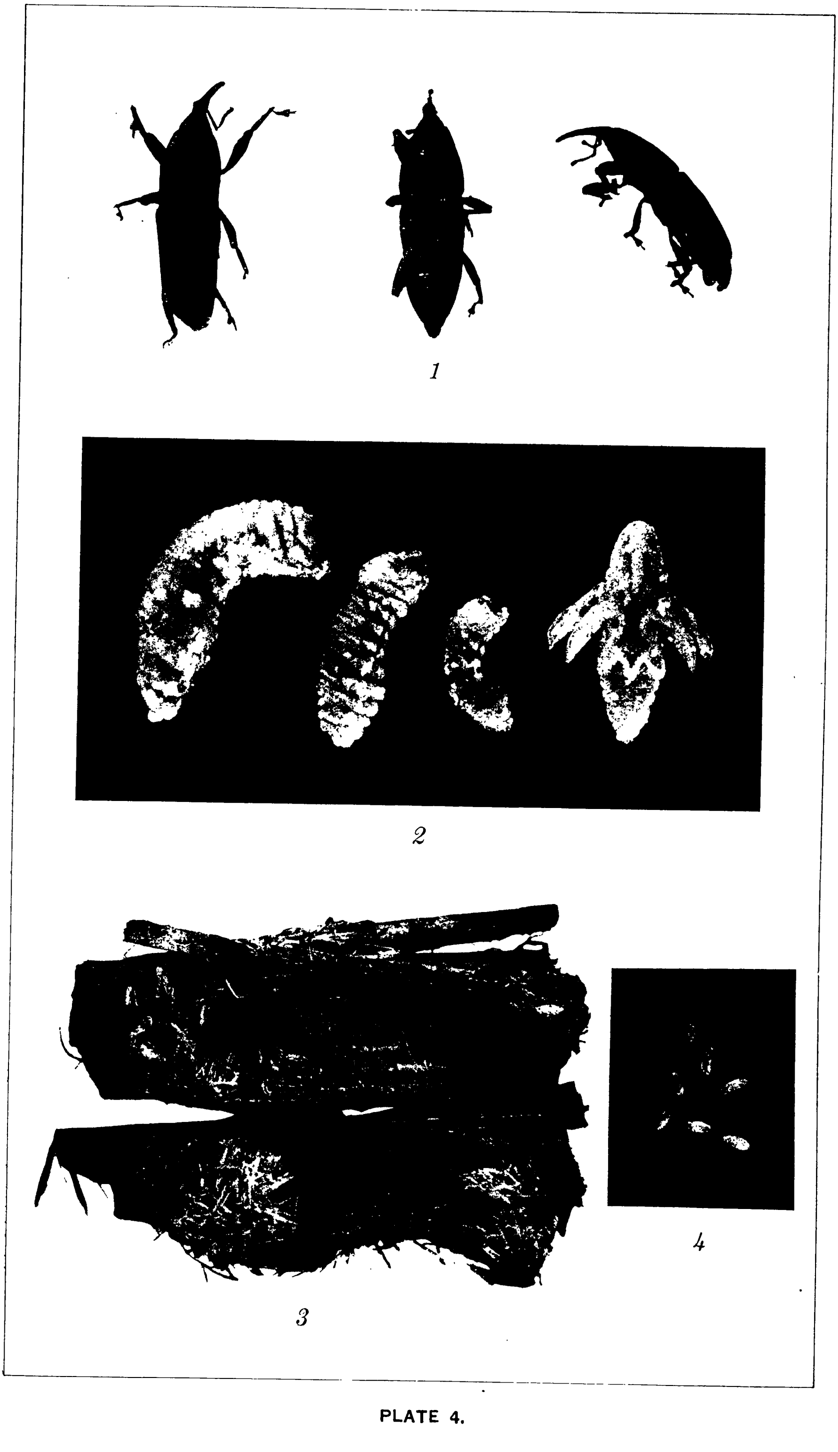


PLATE 4.

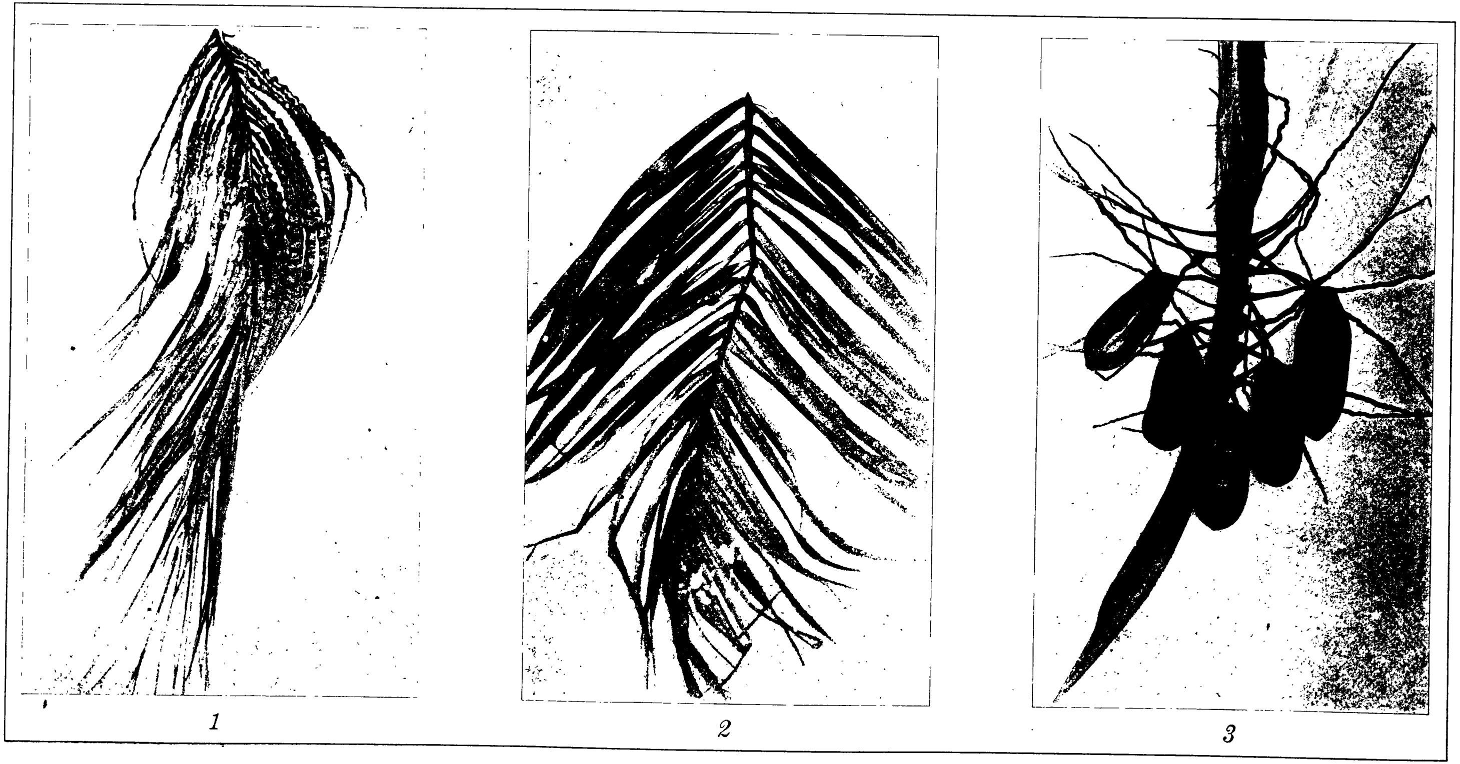


PLATE 5.

1 2 3

PLATE 6.

PLATE 7.

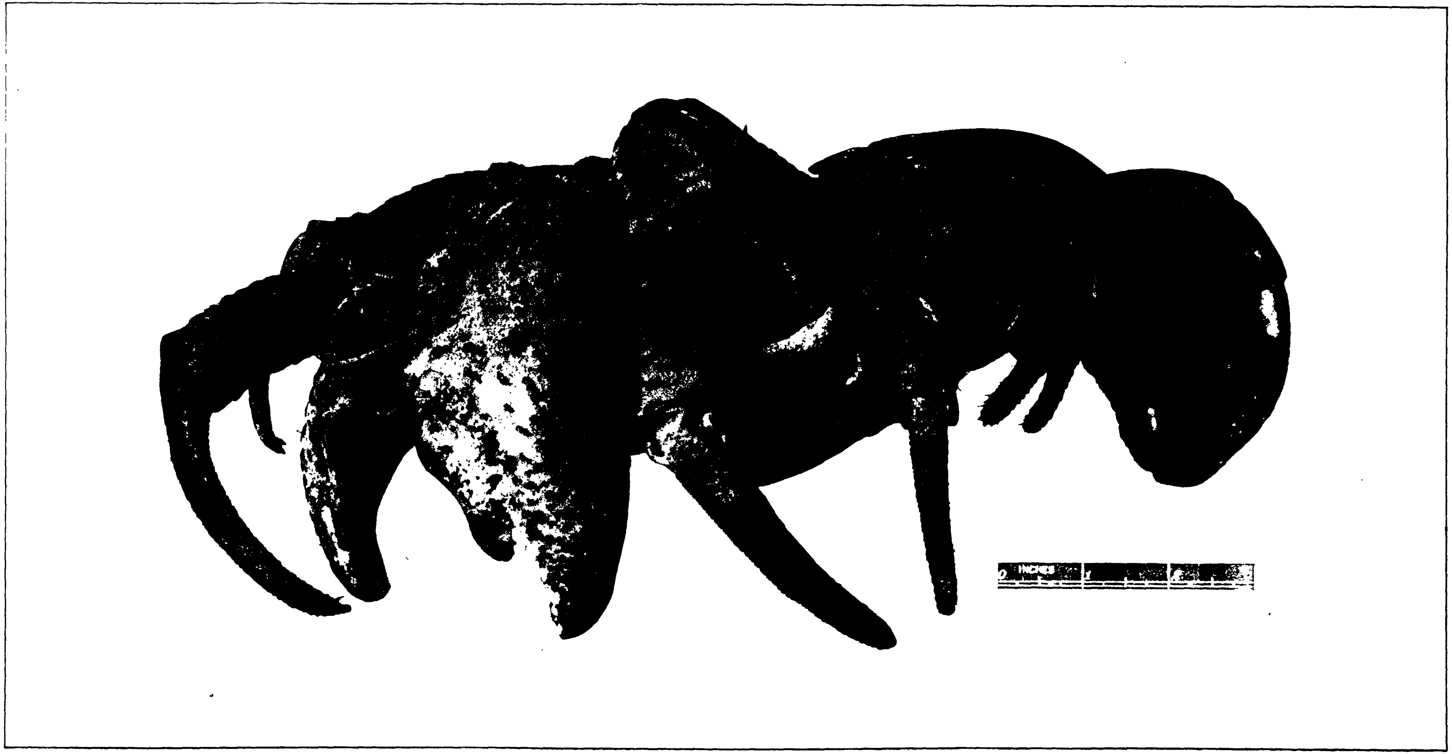


PLATE 8.

THE PHILIPPINE
JOURNAL OF SCIENCE

VOL. 30 . JULY, 1926 No. 3

THE KAHN TEST IN LEPROSY

By M. V. ARGÜELLES

Medical Inspector, Philippine Health Service; Bacteriologist, San Lazaro Hospital, Manila

The view is generally accepted that the results obtained in the examination of serum by the complement fixation test of Wassermann and by the precipitation test of Kahn are very similar. Detweiler,(2) Strumia,(11) Young,(13) and Dulaney(3) have compared the results of the two tests with a range of agreement of from 82.7 to 94.2 per cent. (See Tables 1 and 2.) Keim and Wile(10) compared the results of the two tests in various types of syphilis with an agreement ranging from 45 to 75 per cent, and pointed out a sensitiveness in favor of the Kahn test (Table 3). Ide and Smith(5) in examining 2,165 sera found identical results between the two (Wassermann and Kahn) tests after eliminating the one-plus and doubtful reactions, and concluded that the value of the Kahn test is as great as that of the Wassermann test. Holmes(4) found in 1,000 patients a greater sensitivity to the Kahn test, especially in treated cases. Kahn in 2,060 examinations found an agreement of 97.04 per cent.(6)

Opinion has been and still is unsettled on the reaction of the serum of leper patients when tested by the complement fixation test. The consensus among leprologists and others in the recent past was that the serum of leper patients yielded in various degrees a positive reaction to the old Wassermann test, and by using various antigens. A valuable review of the literature on this point was made by Kolmer and Denney.(8)

Bloomberg (1) in 1911 for the first time called attention to the possibility that the positive Wassermann reaction in leprosy may be due to the concomitant presence of either syphilis or yaws, or both. Kolmer and Denney (8) performed the old Wassermann test by using cholesterinized alcoholic extract of beef heart, plain alcoholic extract of beef heart, and acetone insoluble lipoids as antigens. They also used the new modification of the Wassermann test by Kolmer, according to a standardized technic. (7) The tests were performed on one hundred fifty-nine cases of leprosy, comprising thirty-nine nodular cases, thirty-two anæsthetic cases, and eighty-eight mixed cases. With the new complement fixation test (Kolmer), twenty-seven cases, or 17 per cent, yielded positive reactions, but all of these showed evidences of syphilis. With the old complement-fixation test, the serum of thirty-six cases, or 22 per cent, yielded positive reactions. Twenty-seven of these showed evidences of the presence of syphilis, leaving nine cases, or 5.7 per cent, in which evidences of syphilis could not be found; but the sera yielded a positive reaction, especially with cholesterinized acetone insoluble lipoids as antigens.

Yagle and Kolmer (12) examined twenty-eight leper sera. Twenty-three of these showed no evidences of syphilis, the Kahn reaction was negative in all except two, and the new complement fixation (Kolmer) was negative in all. Two cases of leprosy with suspicious lesions of syphilis gave Kahn plus-minus (±), and the new complement fixation (Kolmer), negative. Their conclusion was that the Kahn precipitation test is uniformly negative in sera of nonsyphilitic lepers.

The positive reactions in the complement fixation test and in the precipitation test are said to be due to the presence in the serum of a so-called "reagin," or "antibody," or a "lipotropic substance."

The experiments reported in this paper were made in order to determine whether or not any of the foregoing substances is present in the serum of leper patients. They were submitted to the Wassermann test, according to the technic used in the Bureau of Science of Manila,[1] and to the precipitation test of Kahn (Rappleyea technic). (9)

The antigen used was a powdered heart muscle extracted four times with ether. The powder, after the ether extraction, was

[1] The Wassermann tests were performed in the Bureau of Science by Drs. Otto Schöbl and José Ramirez.

dried. Five cubic centimeters of 95 per cent alcohol were added to every gram of the dried powder, and extraction therein was continued for three days. Six milligrams of chemically pure cholesterin were then added to every cubic centimeter of this extract.

The cholesterinized antigen was mixed with varying amounts of 0.85 per cent salt solution. Each of the mixtures was titrated with the purpose of determining the mixture which would give a soluble precipitate upon the addition of 0.15 cubic centimeter salt solution and a later addition of 0.5 cubic centimeter salt solution. The mixture giving this result was the one used in making the test.

The test was performed as follows: The antigen was mixed with the amount of salt solution as determined by the foregoing titration. Three test tubes were used, containing 0.05 cubic centimeter, 0.025 cubic centimeter, and 0.0125 cubic centimeter antigen-salt mixture, respectively. The clear serum to be tested was inactivated for thirty minutes at 56° C. To each of the three test tubes, 0.15 cubic centimeter of the inactivated serum was added, the mixture shaken for two minutes, and then incubated in a water bath at 37° C. for fifteen minutes. One-half cubic centimeter of normal salt solution was then added. The results were read immediately after adding the 0.5 cubic centimeter of the normal salt solution. The negative sera were incubated overnight, and another reading was made. In a few cases, the negative sera in the first reading showed positive precipitation after incubation overnight.

NONLEPER SERA

In order to establish a check on the technic used, one hundred sera of nonleper patients were tested, both for the Wassermann and for the Kahn tests. These sera were obtained partly from the venereal clinic and partly from the out-patient department of San Lazaro Hospital. The results are shown in Table 12. A comparison of the agreement is indicated in Table 13. "Absolute agreement" is the term used where the number of pluses with the Wassermann test corresponds exactly with the number of pluses with the Kahn test. "Partial agreement" is used where the difference in the reading between the two tests is "±" or "+." "Nonagreement" is used where the difference is "++" or more. It will be noted that partial agreement, ranging from 76.92 to 100 per cent, was observed in the one hundred sera. In negative cases, a partial agreement of 93 per

cent was obtained, and in positive cases a partial agreement of 93.10 per cent.

The results of the foregoing technic compare favorably with the results obtained by other workers (see Tables 1, 2, and 3), and it was therefore used in testing the sera from leper suspects and leper patients.

LEPER SERA

One hundred sera obtained from the leper patients and leper suspects of San Lazaro Hospital, who consented to have their blood taken, were tested for the Wassermann reaction in the Bureau of Science and for the Kahn test in the San Lazaro Hospital laboratory. These cases consisted of nineteen suspects (having suspicious clinical manifestation of leprosy, but not showing *Bacillus lepræ* under the microscope); seventy-three nodular cases; one macular; and seven mixed. There were eighty males and twenty females. The duration of the disease ranged from several months to ten years. One case was of twenty-one years' duration. There were two cases in whom the duration of the disease was unknown; but, according to the patients, they had had the lesions for many years. The ages ranged from 7 to 65 years.

ANALYSIS OF TABLE 4

Table 4 shows the comparative results of the Kahn and the Wassermann tests. For purposes of comparison, the results "—," "±," and "+" were considered under the general heading of "negative" and the results "++" or more under the general heading of "positive." Accordingly, there were ninety-three Wassermann negatives and ninety-two Kahn negatives in the one-hundred sera. Of the ninety-three Wassermann negatives, three had 2+ Kahn (Nos. 29 and 41 had negative history of syphilis while No. 84 had suspicious syphilitic history) and three cases had 3+ Kahn (Nos. 36, 75, and 96 had negative syphilitic history). Of the ninety-two Kahn negatives, three cases were Wassermann positive (Nos. 18 and 80 had suspicious history of syphilis and case 74 a positive history of yaws).

There were five Wassermann positives. Two of these had syphilitic history, two had history of yaws, and one had no history of either. There were eight Kahn positives, of whom two had history of syphilis, and one of yaws, while the remaining five had no history of either. Summarizing, we see that there was one serum that gave a positive Wassermann determination, and

there were five sera that gave positive Kahn determination, without any history or clinical symptoms of syphilis or yaws.

Two sera gave anticomplementary Wassermann test.

It must here be remarked that, in interpreting the real value of the knowledge as to whether a case has a history of syphilis, in some cases it is very difficult to obtain such a history satisfactorily. This is because syphilis is a disease which has only recently become known among the poor and ignorant class.

ANALYSIS OF TABLES 5 AND 9

Under the classification of "suspect" were included cases which clinically showed manifestations of leprosy, but which were persistently negative for the bacillus of leprosy. Of nineteen suspects, eighteen were negative and one was positive in the Kahn test (No. 98 with positive history of yaws). There were seventeen Wassermann negatives and two positives (No. 98 with positive yaws history and No. 18 with suspicious history of syphilis). Sixty-seven of seventy-three nodular cases were Kahn negative, and six were positive (Nos. 29, 41, 75, and 96 with negative history of syphilis, No. 53 with suspicious history of syphilis, and No. 84 with positive history of syphilis). There were sixty-eight Wassermann negatives and three positives (No. 74, yaws; No. 53, suspicious syphilis; No. 80, suspicious syphilis) and two anticomplementary.

One macular case was negative both to Kahn and to Wassermann.

Six of the seven mixed cases were negative to Kahn and one was positive (No. 36, with negative syphilis history). All these mixed cases were negative to Wassermann.

ANALYSIS OF TABLES 6, 7, 10, AND 11

No definite relation of the occurrence of positive Kahn or Wassermann reaction to the duration of the disease or to the sex of the patient was observed.

SUMMARY AND CONCLUSIONS

1. One hundred nonleper sera, obtained from the venereal clinic and out-patient department of San Lazaro Hospital, were examined for the Wassermann and the Kahn tests. There was an agreement in the results of 93 per cent.

2. One hundred leper and leper-suspect sera were tested by the Wassermann reaction and by the precipitation test of Kahn.

3. There was very close agreement in the results of the Wassermann and the Kahn tests with a slight sensitiveness in favor of the Kahn test.

4. The Wassermann and the Kahn tests in leper patients are generally negative.

5. There was observed, in 1 per cent of leper and leper-suspect sera, positive Wassermann reaction without any history or signs of syphilis or yaws. In confirmed leper sera, the Wassermann test was positive in 1.23 per cent of the cases without any signs or history of syphilis or yaws. Kolmer and Denney found that 7.32 per cent of nonsyphilitic leper sera gave falsely positive Wassermann reaction.

6. The Kahn test was positive in 5 per cent of leper and leper-suspect sera without any signs or history of syphilis or yaws. In confirmed-leper sera, the Kahn test was positive in 6.17 per cent of the cases without any sign or history of syphilis or yaws.

7. As far as lepers are concerned, the Kahn test is of greater value than the Wassermann test in excluding syphilis or yaws, and of less value in establishing the diagnosis of these two diseases.

ACKNOWLEDGMENT

I wish to express my gratitude to the Director of Health for permitting the publication of this paper; to Dr. Catalino Gavino, chief of San Lazaro Hospital; to Dr. Samuel Tietze, resident physician, in charge of the leper department, San Lazaro Hospital, for coöperation and many courtesies during the preparation of the paper; and to Drs. Schöbl and Ramirez, of the Bureau of Science, for performing the Wassermann tests.

TABLE 1.—*Comparative results of complement fixation test and precipitation test of Kahn (various authors).*

Author.	Specimens.	Agreement.	Relative agreement.	Nonagreement.	Remarks.
		Per cent.	*Per cent.*	*Per cent.*	
Detweiler	2,000	94.2			Wassermann.
Strumia		90.0			Kolmer.
Young	8,070	93.754	5.353	0.892	Wassermann.
Dulaney	900	87.77		12.23	Do.
Argüelles	100	93.00		7.00	Do.

TABLE 2.—*Comparison of complement fixation and precipitation reaction in syphilis (Strumia).*

Precipitation test.	Sera tested.	Complement fixation.		Precipitation reactions.			Agreement.
		Positive.	Negative.	Positive.	Negative.	Doubtful.	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Kahn (cholesterinized antigen)	624	41.0	59.0	49.8	48.2	2.0	83.4
Kahn (plain antigen)	566	40.0	60.0	30.4	65.5	4.0	82.7

TABLE 3.—*Comparative results of the Wassermann and the Kahn tests (Keim and Wile).*

Type.	Specimens.	Agreement.	Remarks.
		Per cent.	
Primary syphilis	350	66.6	Remaining 33.3 per cent sensitiveness, favorable to Kahn.
Secondary syphilis		53.3	Remaining 46.6 per cent sensitiveness, favorable to Kahn.
Others remaining		46.6	Sensitiveness, favorable to Kahn.
Cerebrospinal syphilis		45.0	Remaining 55 per cent sensitiveness, favorable to Kahn.
Latent syphilis		76.3	Remaining 23.7 per cent sensitiveness, markedly favorable to Kahn.
Tertiary syphilis			Sensitiveness, markedly favorable to Kahn.
Congenital			Do.

TABLE 4.—*Comparison of results of the Kahn and the Wassermann tests in lepers.*

[K=Kahn; W=Wassermann.]

Examination.	K—	K±	K+	K++	K+++ K++++	Total.
W—	57	5		1	1	64
W±	18	2	1		1	22
W+	1	2	1	2	1	7
W++			2		1	3
W+++ W++++		1			1	2
Anticomplementary	1		1			2
Total	77	10	5	3	5	100

TABLE 5.—*Results of the Kahn test with reference to the types of leprosy.*

Type.	K—		K±		K+		K++		K+++ K++++		Total.	
		P. ct.		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*
Suspect	16	84.2			2	10.52	0		1		19	100
Nodular	55	75.34	9	12.32	3	4.11	3	4.11	3	4.11	73	100
Macular			1						0		1	100
Mixed nodular and anæsthetic	6	85.72							1	14.28	7	100
Total	77		10		5		3		5		100	

TABLE 6.—*Results of Kahn test in relation to the duration of leprosy.*

Duration.	K—	K±	K+	K++	K+++
Years.					
Less than 1	15	3			
1	18	3			
2	15	2		1	1
3	10	1	2	1	1
4	2	1	2	1	1
5	3				
6	7				
7	3				1
8	1				
9					
10	1		1		
More than 10	1				
Unknown	1				
Total	77	10	5	3	4

TABLE 7.—*The Kahn test and the sex of lepers.*

Sex.	K—	K±	K+	K++	K+++	Total.
Male	61	9	5	2	3	80
Female	16	1		1	2	20
Total	77	10	5	3	5	100

TABLE 8.—*Material for this study according to the type of leprosy.*

Type.	Sera.
Suspect	19
Nodular	73
Macular	1
Mixed	7
Anæsthetic	0
Total	100

TABLE 9.—*Results of Wassermann test in relation to the types of leprosy.*

Type.	W—		W±		W+		W++		W+++		Anticomplementary.		Total.
		P. ct.		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*	
Suspect	9	47.36	7	36.84	1	5.26	2	10.52					19
Nodular	50	68.49	13	17.80	5	6.84	1	1.369	2	2.73	2	2.73	73
Macular					1								1
Mixed	5	71.42	2	28.57									7
Total	64		22		7		3		2		2		100

TABLE 10.—*Results of the Wassermann test in relation to the duration of leprosy.*

Duration.	W—	W±	W+	W++	W+++	Anticomplementary.	Total.
Years.							
Less than 1	15	3			1		19
1	16	5	1	0			23
2	12	4	2	0			18
3	8	4	2	1			15
4	0	4	2	1			7
5	2	1					3
6	5	1				1	7
7	2				1		3
8	1						1
9	0						
10	1					1	2
More than 10	1						1
Unknown	1			1			2
Total	64	22	7	3	2	2	100

TABLE 11.—*The Wassermann test and the sex of lepers.*

Sex.	W—	W±	W+	W++	W+++	Total.
Male	54	15	5	3	1	79
Female	11	7	2			21
Total	65	22	7	3	1	100

TABLE 12.—*Comparative results of nonleper sera in the Wassermann and the Kahn tests.*

Examination.	W—	W±	W+	W++	W+++ W++++	Anticomplementary.	Total.
K—	30	6	9		2	5	52
K±	2	3	2				7
K+		1					1
K++	2	2		2	5	1	12
K+++		1	2	3	22		28
Total	34	13	13	5	29	6	100

TABLE 13.—*Tabulated results of agreement of the Wassermann and the Kahn tests in nonleper sera.*

	W−	W±	W++	W+++ W++++	Total.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	
Absolute agreement	88.23	23.07	40.00	75.86	57
Partial agreement, + difference	94.11	76.92	100.00	93.10	93
Nonagreement, + + or more difference	5.89	23.08	0	6.90	7

TABLE 14.—*List of lepers and leper suspects.*

No.	Name.	Wassermann.	Kahn.	Age.	Sex.	Type.	Duration of illness. Yrs.	Duration of illness. mos.
1	C. M	—	—	29	M	Nodular		3
2	D. E	±	—	34	M	Suspect	2	
3	J. C	±	—	44	F	do	4	
4	A. M	±	—	18	M	do		2
5	P. G	±	—	19	F	do	2	
6	S. M	—	—	32	M	Mixed	1	6
7	L. T.C	±	—	24	M	do	6	
8	J. C	—	—	27	M	do	6	
9	T. C.	±	—	32	M	Suspect	2	6
10	P. M	±	—	38	M	Nodular		11
11	A. N	—	—	15	F	do	2	
12	B. E	—	—	65	M	Suspect		2
13	M. C	—	—	37	M	Nodular	10	
14	C. R	—	—	18	M	do	6	
15	L. A	±	—	66	M	do	3	
16	A. G	±	—	32	M	Suspect	3	
17	Y. P	±	—	21	M	Mixed		6
18	B. R	++	+	60	M	Suspect	3	
19	A. M	—	—	56	M	do		5
20	A. G	—	—	57	M	do	3	
21	N. A	—	—	59	M	Nodular	1	
22	I. R	—	—	22	M	Suspect	1	7
23	A. P	±	—	16	M	do	1	
24	O. P	—	—	22	M	Nodular	1	
25	J. C	—	—	45	M	do	2	
26	F. F	—	—	25	F	Suspect	5	
27	A. A	+	+	20	M	do	3	
28	J. L	—	—	30	F	do	7	
29	G. A	+	++	36	F	Nodular	4	
30	P. V	—	—	35	M	do	6	
31	J. A	+	—	17	M	do	1	
32	M. P	—	—	38	M	Mixed	21	
33	J. F	±	—	14	M	Nodular	4	
34	R. F	—	—	46	M	do	5	
35	H. S	—	—	19	M	do	1	
36	L. S.	—	+++	19	M	Mixed	2	
37	A. C	—	±	21	M	Nodular		6
38	E. M	—	—	41	M	do		4
39	V. M	—	—	24	M	do	2	

TABLE 14.—*List of lepers and leper suspects*—Continued.

No.	Name.	Wasser-mann.	Kahn.	Age.	Sex.	Type.	Duration of illness.	
							Yrs.	*mos.*
40	J. C	—	—	55	M	Suspect	1	
41	P. S	—	++	35	M	Nodular	3	
42	P. R	—	—	19	M	do	3	
43	P. R	—	—	22	M	do	1	
44	F. F	—	—	19	M	do		10
45	M. I	—	—	33	M	Mixed	1	
46	C. S	—	—	37	M	Suspect		7
47	S. T	—	—	39	M	Nodular	1	6
48	A. M	±	—	15	M	do	1	
49	F. G	([a])	—	30	M	do	6	
50	F. S	—	—	14	M	do	6	
51	M. E	—	—	11	M	do	6	
52	G. G	—	—	35	F	do		4
53	A. M	+++	+++	28	F	do	7	
54	M. G	—	—	30	F	do	3	
55	G. C	±	+	30	F	do	4	
56	M. B	—	—	25	F	Suspect	1	
57	B. B	—	±	23	M	Nodular		9
58	M. M	±	—	18	F	do	1	6
59	G. V	—	—	30	M	do	2	
60	J. M	([a])	+	22	M	do	10	
61	V. R	—	—	29	M	do		2
62	P. H	—	—	34	M	do		11
63	M. S	—	—	18	F	do	3	
64	E. L	—	—	18	M	do	1	
65	E. C	+	±	19	M	do	2	
66	A. M	—	±	30	M	do	1	2
67	P. F	±	—	16	F	do	1	
68	M. C	+	±	22	F	Macular	3	
69	A. S	—	—	27	M	Nodular	8	
70	F. G	±	±	24	M	do	1	
71	T. A	—	—	50	M	do		6
72	P. A	—	—	34	M	do	3	
73	F. B	—	—	50	M	do		11
74	F. C	+++	±	21	M	do		8
75	A. C	+	+++	22	M	do	4	
76	J. G	—	—	42	M	do	1	
77	B. G	—	—	15	M	do	3	
78	L. G	—	—	15	M	do	1	
79	R. L	—	—	57	M	do	2	
80	F. M	++	+	37	M	do	4	
81	U. M	—	—	42	M	do	7	
82	L. R	—	—	22	M	do	2	
83	A. P	—	—	17	M	do	2	
84	B. R	+	++	17	M	do	1	6
85	M. B	—	—	7	M	do		3
86	C. C	—	—	15	M	do		8
87	P. A	—	—	50	F	do	3	
88	T. L	—	—	30	F	do	1	
89	E. A	—	—	10	F	do	([b])	
90	R. I	—	—	15	F	do	1	

[a] Anticomplementary. [b] Unknown.

TABLE 14.—*List of lepers and leper suspects*—Continued.

No.	Name.	Wasser-mann.	Kahn.	Age.	Sex.	Type.	Duration of illness.	
							Yrs.	*mos.*
91	C. B	±	—	30	F	Nodular	5	
92	P. C	—	—	45	M	do	1	
93	B. B	±	—	40	F	do	1	3
94	A. B	—	—	19	M	do	2	
95	T. F	—	±	39	M	do	1	
96	F. E	±	+++	19	F	do	3	?
97	P. G	±	±	57	M	do	4	
98	I. J	++	+++	65	M	Suspect	([b])	
99	P. E	—	±	20	M	Nodular	2	
100	C. S	±	—	27	M	do	1	6

[b] Unknown.

REFERENCES

1. BLOOMBERGH, H. D. Philip. Journ. Sci. § B 6 (1911) 335.
2. DETWEILER, H. K. Journ. Am. Med. Assoc. 81 (1923) 815.
3. DULANEY, A. D. Am. Journ. Pub. Health 13 (1923) 472–474.
4. HOLMES, J. A. Journ. Am. Med. Assoc. 81 (1923) 294.
5. IDE, P., and G. SMITH. Arch. Derm. & Syph. 6 (1922) 770.
6. KAHN, R. L. Journ. Am. Med. Assoc. 81 (1923) 88–92.
7. KOLMER, J. A. Am. Journ. Syph. 6 (1922) 82–110, 496–498.
8. KOLMER, J. A., and O. E. DENNEY. Arch. Derm. & Syph. 8 (1923) 63–72.
9. RAPPLEYEA, G. W. Military Surg. 56 (1925) 356.
10. STITT, E. R. Practical Bacteriology, Bloodwork and Animal Parasitology. Philadelphia, P. Blakiston's Son & Co. 7th ed. (1923).
11. STRUMIA, M. M. Arch. Derm. & Syph. 8 (1923) 50.
12. YAGLE, E. M., and J. A. KOLMER. Arch. Derm. & Syph. 8 (1923) 183–185.
13. YOUNG, C. C. Am. Journ. Pub. Health 13 (1923) 16–99.

ANALYSES OF CHINESE FOOD MATERIALS

By WILLIAM H. ADOLPH

Of the Laboratory of Chemistry, Shantung Christian University, Tsinanfu, China

The available data on the chemical composition of Chinese foodstuffs published to date [1] is meager and touches only the fringe of this large field. In the case of the prepared foods, samples vary greatly in different localities. In the Occident, recent years have seen the growth of an intelligent interest in the contributions to food science which the experience of the Orient, extending over thousands of years, has to offer. Furthermore, a real need now exists for analytical data as an aid to dietary studies in China, and as a basis for more carefully regulated hospital diets. A large amount of data on Chinese foods must be accumulated that these needs may be met more adequately.

The laboratory of chemistry of Shantung Christian University has during the last few years carried out a large number of chemical analyses of Chinese foodstuffs, for use in dietary and nutrition studies. A few of these analyses have been published.[2] Data on some additional food materials are presented in this paper as Tables 1 and 2.

The analyses here given [3] are all for materials purchased on the streets of Tsinanfu, the capital of Shantung Province.

[1] Among the most important contributions on the analysis of Chinese food materials should be mentioned the following: W. C. Blasdale, Bull. U. S. Dept. Agr. Exp. Sta. No. 68 (1899); K. Blunt and C. C. Wang, Journ. Biol. Chem. 28 (1916) 125; B. E. Read, Journ. Am. Chem. Soc. 40 (1918) 817; C. O. Levine and W. W. Cadbury, China Med. Journ. 32 (1918) 536; H. Embrey and T. C. Wang, China Med. Journ. 35 (1921) 247; C. C. Wang, Journ. Biol. Chem. 49 (1921) 429.

[2] W. H. Adolph and P. C. Kiang, China Med. Journ. 34 (1920) 268; W. H. Adolph and C. M. Wu, National Med. Journ. (China) 6 (1920) 231; W. H. Adolph, Journ. Home Econ. 14 (1922) 63.

[3] The author is indebted to some of his students for assistance in carrying out the routine determinations. Thanks are due to Prof. A. P. Jacot of Shantung Christian University for establishing the botanical identity of a number of the vegetable foodstuffs.

Where necessary, the analysis is given both in terms of the edible portion (E. P.), and of the material as purchased (A. P.). The standard methods of the Association of Official Agricultural Chemists (1920 edition) were followed in making the analyses. The Soxhlet apparatus was used in the determination of the fats. All analyses were performed in duplicate. In calculating the fuel value, 1 gram of protein was reckoned as yielding 4 calories; 1 gram of fat, 8.9 calories; and 1 gram of carbohydrate, 4 calories.

TABLE 1.—*Analyses of Chinese food materials (animal food).*

[A.P. = as purchased; E.P. = edible portion.]

Analysis No.	Food materials: Chinese names (Peking romanized).	Food materials: English name.	Refuse.	Water.	Protein: N × 6.25.	Protein: By difference.	Fat.	Total carbohydrates.	Ash.	Fuel value (calculated): Per pound.	Fuel value (calculated): Per 100 grams.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Calories.*	*Calories.*
		Shellfish, etc.:									
45	Hai-shen	Sea slugs, A. P.		4.99	44.22		0.92	8.09	41.78	976	217
86	Hai-mi	Dried shrimps, A. P.		25.72	46.33		1.97	0.86	25.12	922	205
		Eggs:									
44	Chi-tan	Hens' eggs (whole egg), E. P.		70.98	13.30	14.67	12.82		1.53	779	173
44	do	Hens' eggs (whole egg), A. P.	14.26	60.86	11.40	12.58	10.99		1.31	666	148
42	Chi-tan-huang	Hens' eggs: yolk		51.92	15.49	16.82	28.85		2.41	1,460	324
43	Chi-tan-pai	Hens' eggs: white		86.17	11.55	12.99	0.02		0.82	234	52
41	Pien-tan	Preserved eggs (whole egg), E. P.		67.26	15.29	17.57	12.45		2.72	814	181
41	do	Preserved eggs (whole egg), A. P.	13.33	58.29	13.25	15.23	10.79		2.36	706	157
39	Pien-tan-huang	Preserved eggs: yolk		63.13	14.22	16.61	17.86		2.40	1,012	225
40	Pien-tan-pai	Preserved eggs: white		76.76	17.75	19.77	0.01		3.46	356	79

TABLE 2.—*Analyses of Chinese food materials (vegetable food).*

[A. P. = as purchased; E. P. = edible portion.]

Analysis No.	Food materials. Chinese name (Peking romanized).	Food materials. English name.	Food materials. Botanical name.	Refuse.	Water.	Protein N × 6.25.	Fat.	Nitrogen-free extract (carbohydrates).	Fiber.	Ash.	Fuel value (calculated). Per pound.	Fuel value (calculated). Per 100 grams.
				P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Calories*	*Calories*
		Cereals and cereal preparations:										
53	Hsiao-mai	Wheat, A. P.	*Triticum vulgare*		7.77	11.55	1.81	74.96	1.10	2.81	1,629	362
65	Ta-mi (Tao)	Rice, A. P.	*Oryza sativa*		10.05	9.60	0.19	79.63	0.24	0.29	1,616	359
66	No-mi	Glutinous rice, A. P.	*Oryza glutinosa*		11.52	5.84	0.21	81.93	0.36	0.14	1,584	352
47	Hsiao-mi (Su)	Spiked millet, A. P.	*Setaria italica*		9.48	9.67	4.18	74.03	0.85	1.79	1,674	372
48	Huang-mi (Chi)	Panicled millet (glutinous), A. P.	*Panicum miliaceum*		8.49	10.88	3.36	74.63	1.02	1.62	1,674	372
49	Kao-liang (Shu-shu)	Barbadoes millet (kaoliang), red variety, A. P.	*Sorghum vulgare*		12.05	8.01	4.18	72.61	1.82	1.33	1,620	360
51	do	Barbadoes millet (kaoliang), yellow variety, A. P.	do		5.58	9.71	4.12	78.04	1.44	1.11	1,742	387
52	do	Barbadoes millet (kaoliang), white variety, A. P.	do		3.68	9.32	4.95	80.11	0.39	1.55	1,809	402
67	Ts'an-tzu	Finger millet, A. P.	*Eleusine coracana*		8.50	5.84	5.75	74.26	2.01	3.64	1,679	373
36	Yü-shu-shu	Corn (maize), A. P.	*Zea mays*		8.99	8.56	4.40	74.92	1.28	1.85	1,679	373
35	Mien-t'iao	Noodles (wheat flour), A. P.			33.22	8.05	0.65	56.34	0.35	1.39	1,188	264
34	do	Noodles (mixed flour), A. P.			28.30	20.21	1.60	44.82	1.30	3.77	1,233	274
37	Kua-mien	Vermicelli (wheat flour) A. P.			13.61	11.21	1.32	69.24	0.49	4.13	1,503	334
		Bread, Pastry, etc.:										
55	Man-t'ou (Mo-mo)	Steamed bread, A. P.			38.87	8.24	0.09	52.01	0.06	0.73	1,089	242

54	Kuo-ping	Baked bread (large loaf) (wheat flour), A. P.			30.06	9.80	0.23	58.74	0.29	0.88	1,242	276
96	Shao-ping	Baked bread (small loaf), A. P.			23.79	8.30	1.46	65.11	0.19	1.15	1,381	307
56	Wo-wo-t'ou (P'a-ku)	Bean-millet bread, A. P.			39.97	10.85	3.61	43.07	1.22	1.28	1,116	248
57	Chien-ping	Fried bread (thin sheets), A. P.			22.73	11.77	2.70	60.54	0.80	1.46	1,408	313
62	Mien-chin	Wheat gluten, A. P.			74.79	22.44	0.15	1.33	0.55	0.74	432	96
85	Yu-ping	Oil cakes, A. P.			40.45	5.22	6.89	44.65	0.46	2.33	1,175	261
94	Yu-kuo	Doughnuts, A. P.			9.90	5.10	30.03	53.21	0.23	1.53	2,250	500
103	Kuo-t'ieh	Dumpling (fried), A. P.			57.04	6.17	10.44	24.44	0.52	1.39	972	216
98	Chi-tan-kao	Sponge cake, A. P.			24.30	10.87	8.21	55.81	0.06	0.75	1,530	340
		Beans and bean products:										
82	Hei-tou	Soy bean (black variety), A. P.	*Glycine hispida*		8.42	42.92	12.56	25.96	6.21	3.93	1,746	388
20	Chiang-yu	Soy (from soy bean), A. P.			57.00	9.34	9.00	4.09		20.57	598	133
22	Tou-chiang	Bean condiment (from soy bean), A. P.			45.04	18.94	10.08	1.48	1.98	22.48	774	172
24	Tou-fu-p'i	Bean curd skin (from soy bean), A. P.			5.66	50.99	21.24	17.57		4.54	2,083	463
25	Ch'ien-chang-tou-fu	Sheet bean curd (from soy bean), A. P.			64.59	20.28	7.36	4.27	0.08	3.42	738	164
26	Tou-fu-nao	Bean curd bran (from soy bean), A. P.			94.42	3.33	1.18	0.50		0.57	117	26
27	Fu-ju	Bean curd pickle (from soy bean), A. P.			53.68	17.60	8.82	4.55		15.35	751	167
29	Tou-ch'ih	Bean relish (from soy bean), A. P.			29.84	32.68	14.14	4.76	2.41	16.17	1,242	276
58	Lü-tou	Green beans, A. P.	*Phaseolus mungo*		4.52	22.31	1.04	64.90	4.26	2.97	2,696	599
71	Lü-tou-ya	Bean sprouts (from green beans), A. P.	do		92.50	2.77	0.35	2.78	1.07	0.53	112	25
59	Kan-fen	Bean starch (strips) (from green beans), A. P.			10.41	0.65	0.20	88.10	0.36	0.28	1,606	357
60	Fen-p'i	Bean starch (sheets) (from green beans), A. P.			16.92	0.61	0.06	81.51	0.75	0.15	1,481	329

TABLE 2.—*Analyses of Chinese food materials (vegetable food)*—Continued.

Analysis No.	Food materials. Chinese name (Peking romanized).	English name.	Botanical name.	Refuse.	Water.	Protein N × 6.25.	Fat.	Nitrogen-free extract (carbohydrates).	Fiber.	Ash.	Fuel value (calculated). Per pound.	Per 100 grams.
		Beans and bean products—Ctd.										
				P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Calories*	*Calories*
61	Yang-fen	Bean starch (from green beans), A. P.			2.85	1.53	0.19	94.23	0.53	0.67	1,733	386
99	Fen-t'iao	Do.			0.08	3.09	0.16	96.02	0.31	0.34	1,787	397
88	Pai-pien-tou	Flat bean, A. P.	*Dolichos lablab*		11.34	17.93	1.77	57.04	8.90	3.02	1,422	316
110	Ch'ing-tou	Soy bean (green variety), A. P.	*Glycine hispida*		6.38	37.34	18.33	29.56	3.38	5.01	1,940	431
111	Pai-chiang-tou	Do.	*Vigna sinensis*		10.34	21.25	2.16	58.53	4.32	3.40	1,525	339
112	Hei-chiang-tou	Do.	*do.*		9.14	22.64	2.14	58.42	4.15	3.51	1,548	344
113	Hsiao-tou	Red bean, A. P.	*Phaseolus radiatus*		10.34	18.31	1.32	63.05	3.73	3.25	1,516	337
114	Ts'an-tou	Horse bean, A. P.	*Vicia faba*		7.51	25.60	2.81	51.76	8.80	3.52	1,503	334
		Vegetables:										
50	Ou	Lotus root, A. P.	*Nelumbium speciosum*		86.72	1.66	0.09	9.67	0.76	1.10	212	47
101	Ou-fen	Lotus root flour, A. P.	do.		10.19	0.78	0.53	87.49	0.31	0.70	1,611	358
63	Shan-yao	Yam, A. P.	*Dioscorea batatas*		76.80	2.21	0.06	19.63	0.61	0.69	396	88
118	Hung-shu	Sweet potato, A. P.	*Ipomoea batatas*		81.60	1.34	0.05	16.23	0.31	0.47	320	71
68	P'o-ch'i	Water chestnut, E. P.	*Eleocharis tuberosa*		79.20	1.84	0.18	17.12	0.70	0.96	347	77
	do.	Water chestnut, A. P.	do.	16.48	66.14	1.53	0.15	14.32	0.58	0.80	288	64
64	Pai-ts'ai	Cabbage, A. P.	*Brassica chinensis*		95.42	1.21	0.06	1.99	0.76	0.56	63	14
122	Pai-lo-po	Turnip, A. P.	*Raphanus sativus*		93.56	1.68	0.02	2.94	1.16	0.64	85	19
79	Ch'ieh-tzu	Eggplant, E. P.	*Solanum melongena*		93.26	2.31	0.07	3.05	0.77	0.54	99	22
	do.	Eggplant, A. P.	do.	3.86	89.66	2.22	0.06	2.94	0.74	0.52	95	21
89	Ch'in-ts'ai	Celery, E. P.	*Apium graveolens*		94.62	1.76	0.20	1.04	0.58	1.80	58	13
	do.	Celery, A. P.	do.	28.05	68.08	1.26	0.14	0.75	0.42	1.30	41	9
119	Wo-chü	Chinese lettuce, A. P.	*Lactuca sativa*		93.23	0.47	0.04	5.06	0.61	0.59	104	23
72	P'u-ts'ai	Bulrush, E. P.	*Acorus calamus*		96.24	0.88	0.12	1.16	0.65	0.95	41	9

	do	Bulrush, A. P.	do	44.84	53.08	0.48	0.06	0.65	0.36	0.53	23	5
95	Huang-hua-ts'ai	Yellow day-lily, A. P.	*Hemerocallis aurantiaca*		8.56	12.65	1.87	59.00	12.27	5.65	1,364	303
109	Po-ts'ai	Spinach, E. P.	*Spinacia oleracea*		93.85	1.86	0.20	1.78	0.51	1.80	72	16
	do	Spinach, A. P.	do	12.80	81.83	1.62	0.17	1.56	0.44	1.58	63	14
87	Mu-erh	Mushroom, A. P.	*Peziza auricula*		14.90	11.28	2.02	61.51	8.37	1.92	1,391	309
		Fruits, nuts, etc.:										
74	Hsing	Apricot, E. P.	*Prunus armeniaca*		85.00	1.15	0.03	11.11	1.88	0.83	220	49
74	do	Apricot, A. P.	do	44.36	47.29	0.64	0.02	6.19	1.04	0.46	126	28
97	Shih-tzu	Persimmon, E. P.	*Diospyros kaki*		82.75	0.74	0.08	10.51	3.06	2.86	198	44
	do	Persimmon, A. P.	do	14.14	71.05	0.63	0.07	9.03	2.62	2.46	176	39
80	Hei-tsao	Dates, E. P.	*Zizyphus jujuba*		14.98	7.07	0.94	67.52	6.64	2.85	1,382	307
	do	Dates, A. P.	do	13.83	12.90	6.09	0.81	58.19	5.72	2.46	1,193	265
69	Lien-tzu	Lotus seeds, A. P.	*Nelumbium speciosum*		4.82	15.92	2.82	70.06	2.50	3.88	1,661	369
75	Pei-kua-tzu	Pumpkin seeds, E. P.	*Cucurbita moschata*		0.46	35.97	32.62	24.04	2.42	4.49	2,385	530
	do	Pumpkin seeds, A. P.	do	25.69	0.34	26.74	24.23	17.86	1.80	3.34	1,755	390
76	Hsi-kua-tzu	Watermelon seeds, E. P.	*Citrullus vulgaris*		10.34	30.84	44.66	5.73	3.76	4.67	2,468	544
	do	Watermelon seeds, A. P.	do	62.78	3.84	11.48	16.62	2.14	1.40	1.74	905	201

STUDIES ON THE SEROLOGY OF LEPROSY, III

THE KAHN PRECIPITATION REACTION IN LEPROSY [1]

By ELOY V. PINEDA

Of the Pathological Section, Culion Leper Colony, Philippine Health Service

and

ELISA ROXAS-PINEDA

Of the Medical Section, Culion Leper Colony, Philippine Health Service

Recent reports [2] to the effect that the Wassermann reaction is negative in leprosy uncomplicated by treponematous infection, corroborated by our findings [3] at least for the ordinary phases of the disease, are contrary to the usual belief that infection with *Mycobacterium lepræ* per se gives rise to this reaction. So firmly established is this belief that corroboration by means of another test used in the diagnosis of syphilis is desirable.

Of the many other tests advocated for the serum diagnosis of syphilis, the Kahn precipitation reaction has recently received most favorable reports. It is apparently specific and sensitive,[4] and is certainly simple and less liable to technical and

[1] Published with the permission of the Director of Health, on recommendation of the Philippine Leprosy Research Board.

[2] Mathis, C., La reaction de Wassermann dans la lépre. Troisième Conference International Scientifique de la Lépre, Strassbourg, 1923. Paris, J. B. Ballière et Fils (1924) 229–231.

Kolmer, J. A., and O. E. Denney, Arch. Derm. & Syph. **8** (1923) 63.

[3] Philip. Journ. Sci. **30** (1926) 39–57.

[4] Keim, H. L. and U. J. Wile, The Kahn precipitation test in the diagnosis of syphilis, Journ. Am. Med. Assoc. **79** (1922) 870.

Rothberg, William, A comparative study of the Kahn precipitation test with the Kolmer modification of the Wassermann, Abstracts Bacteriol. **8** (1924) 29.

Ishii, O., Comparative studies on the Kahn precipitation test for syphilis serum and the Wassermann test, Arch. Derm. & Syph. **9** (1924) 612.

Holmes, J. A., The Kahn precipitation test for syphilis, Journ. Am. Med. Assoc. **81** (1923) 294–295.

Young, C. C., Public health value of the Kahn test for syphilis, Preliminary report based on 5,000 examinations, Journ. Am. Med. Assoc. **79** (1922) 1674.

Litterer, W., Comparison of the Wassermann test with the Kahn flocculation test in 1,000 cases, Journ. Am. Med. Assoc. **80** (1923) 1406.

Keim, H. L., and R. L. Kahn, Clinical studies on the Kahn reaction for syphilis, I. Diagnostic value of test, Arch. Derm. & Syph. **10** (1924) 722.

other errors than is the Wassermann reaction. It is therefore well suited to the purpose of determining whether in leprosy there are produced reacting bodies of similar nature to those characteristic of treponematous infections.

It has been so used by Yagle and Kolmer[5] on the sera of twenty-eight cases of leprosy, with regularly negative results in cases uncomplicated with treponematous infections. More recently Hasseltine[6] also used it in this connection; but, as he was not satisfied with his technic, he did not arrive at any definite conclusion. In the present paper are reported our findings with this test. The Wassermann reaction was performed in parallel on all sera.

Material.—Sera from two hundred fifty cases of leprosy were tested (see Table 1). These were unselected, except that a considerable number (fifty-four) of lepra-reaction cases was included, because a small proportion of this group were weakly or doubtfully positive with the Wassermann reaction. The majority were under anti-leprosy treatment. Eighteen were on the "negative list" and were ready for parole. All were carefully questioned and examined for any evidence of treponematous infection.

Technic.—The technic followed was the improved one described by Kahn.[7] During the early part of the work a cholesterinized antigen kindly supplied by Doctor Kahn was used; later an antigen was prepared in the Culion laboratory that gave identical results when tested in parallel with the first. Only the averages of the three tube readings are here reported. It was noted that in some instances the largest amount of precipitation occurred in the first tube, while it was distinctly less in the two tubes having a higher serum antigen dilution, which is contrary to the rule. Ishii[8] noted similar results.

Results.—The results are summarized in Table 1. The cases were divided into three groups; one suspected of having syphilis, one of having yaws, and one in which there was no distinct clinical evidence of either of these diseases.

As has been stated by us in a former paper,[9] the larger number of cases giving evidence of yaws (seventeen) than of syphilis (eleven) is in conformity with existing conditions in the

[5] Arch. Derm. & Syph. **8** (1923) 183–185.
[6] Pub. Health Bull. No. **141** (1924) 27–49.
[7] Am. Journ. Pub. Health (June, 1924) 491.
[8] Arch. Derm. & Syph. **9** (1924) 612.
[9] Philip. Journ. Sci. **30** (1926) 53.

Philippine Islands, syphilis being found chiefly in the larger cities while yaws is endemic and prevalent in many localities in the provinces.

TABLE 1.—*Cases of leprosy whose sera were tested.*

Cases examined.	Number of cases.	Positive Kahn.	Negative Kahn.
No suspicion of syphilis or yaws	222	8	214
Yaws suspected	17	17	0
Syphilis suspected	11	11	0
Total	250	36	214

In every case where either of these complications was diagnosed or suspected a positive reaction was obtained. These diagnoses were not made on highly doubtful evidence; that would not be justifiable in the presence of a disease such as leprosy. It is therefore to be expected that some of those passed as not suspicious should give positive reactions, particularly since many of these patients are very ignorant. However, this occurred in but eight out of two hundred twenty-two cases of leprosy of various types and stages of development. Data on the apparently uncomplicated cases showing positive reactions are given in Table 2.

In Tables 2, 3, and 4 the following abbreviations are used:

M = mixed.
C = cutaneous.
N = neural.
Mod = moderate.
Mkd = marked.
Sl = slight.

TABLE 2.—*Cases of leprosy, without history or clinical evidence of syphilis or yaws, giving positive Kahn reaction.*

No.	Age.	Leprosy.				Kahn reaction.[a]	Wassermann reaction.[b]
		Type.	Stage.	Duration.	Bacteriological examination.		
	Yrs.			*Yrs.*			
1	23	M	Mod	2	+	4+	4+
2	65	M	Mkd	9	+	4+	4+
3	45	M	Mod	3	+	4+	4+
4	13	M	Mkd	5	+	3+	3+
5	15	M	Sl	5	+	2+	1+
6	35	M	Mod	?	+	4+	3+
7	22	M	Mod	7	+	4+	4+
8	38	M	Mod	6	+	4+	4+

[a] Average of three tube readings.
[b] Kolmer standardized technic.

With a single exception these uncomplicated cases gave very strongly positive Kahn reactions, and the Wassermann reactions were also strong. In the exceptional case the leprosy was very slight, and could hardly be expected to give rise to a false positive reaction; furthermore, there were scars on the legs of this patient suspicious of yaws. Four of these cases were Moros among whom, as stated in the former paper, yaws is very common. The remaining three cases were rendered negative by neoarsphenamine injections, indicating treponematous infection. In our work with the Wassermann reaction we arrived at the conclusion that the cases that gave strongly positive reactions were suffering from either yaws or syphilis, and the evidence in the present instance points strongly to the same conclusion.

Data on the cases suspected of having yaws are given in Table 3. It is to be noted that the Kahn precipitation reaction, like the Wassermann reaction, is positive in cases of yaws, and that on the whole it is as strongly positive as is the Wassermann.

TABLE 3.—*Cases of leprosy complicated with yaws.*

No.	Age.	Leprosy. Type.	Leprosy. Stage.	Leprosy. Duration.	Leprosy. Bacteriological examination.	Kahn reaction.[a]	Wassermann reaction.[b]
	Yrs.			*Yrs.*			
1	17	M	Mkd	6	+	4+	4+
2	30	M	Mod	3	+	2+	3+
3	59	M	Mod	4	+	4+	4+
4	25	M	Mkd	3	+	2+	3+
5	26	M	Mkd	15	+	4+	4+
6	45	M	Mod	4	+	4+	4+
7	24	N	Mkd	13	—	4+	4+
8	14	M	Mkd	6	+	4+	4+
9	34	M	Mod	9	+	4+	4+
10	35	M	Mkd	9	+	4+	4+
11	17	M	Mkd	11	+	4+	4+
12	26	N	Mod	11	+	4+	4+
13	24	M	Mod	14	+	3+	3+
14	35	M	Mkd	12	+	3+	2+
15	17	M	Sl	10	+	3+	4+
16	23	M	Mkd	9	+	2+	4+
17	22	M	Mod	5	+	4+	4+

[a] Average of three tube readings. [b] Kolmer standardized technic.

Data on the eleven cases complicated with syphilis are given in Table 4. It is interesting to note that both the Kahn and

the Wassermann reactions are weaker in this group than in the yaws group. In these cases the infection was in a latent form; none of them showed acute manifestations of syphilis. There is a general impression among laboratory workers in the Philippines that in latent yaws the serum reacts more strongly than in latent syphilis as found in the general run of cases among the native population. The results obtained seem to bear out this belief.

TABLE 4.—*Cases of leprosy complicated with syphilis.*

No.	Age.	Leprosy.				Kahn reaction.[a]	Wassermann reaction.[b]
		Type.	Stage.	Duration.	Bacteriological examination.		
	Yrs.			*Yrs.*			
1	51	M	Sl	4	+	3+	4+
2	31	M	Mod	10	+	2+	1+
3	44	M	Mod	9	+	4+	±
4	45	M	Mod	2	+	3+	4+
5	34	C	Sl	5	+	3+	2+
6	27	N	Mkd	10	—	2+	4+
7	28	M	Mkd	18	+	3+	3+
8	28	M	Sl	3	+	3+	2+
9	25	M	Mod	4	+	3+	3+
10	55	M	Mkd	15	+	3+	3+
11	35	M	Mkd	9	+	4+	2+

[a] Average of three tube readings. [b] Kolmer standardized technic.

Lepra reaction.—A point of interest is that the Kahn test has not given any doubtfully positive results in cases of lepra reaction as did the Wassermann reaction. Fifty-four cases of lepra reaction are included in this group. Nine sera from these gave doubtful or weakly positive Wassermann reactions, while the precipitation test was negative in all. After an interval of time, during which in most of the cases the lepra reaction had subsided, retests were made. In seven the Wassermann reaction had become entirely negative; but in two, in which the lepra reaction had persisted, the Wassermann still gave plus-minus readings. The precipitation reaction was again negative.

Effect of antitreponematous treatment.—Fourteen of the patients giving positive Kahn reactions were given antitreponematous treatment and their sera were retested one or more times. Data on these cases are given in Table 5.

TABLE 5.—*Kahn reaction before and after treatment with neoarsphenamine.*

No.	Clinical diagnosis.	Reaction before treatment.	Injections.	Time interval, last injection.	Reaction after treatment.
				Months.	
1	Yaws	4+	5	8	1+
2	do	4+	7	3	—
3	do	4+	6	3	—
4	do	3+	7	3	—
5	do	2+	4	3	—
6	do	4+	8	2	[a]2+
7	Syphilis	4+	8	4	—
8	do	3+	8	4	—
9	do	2+	3	3	—
10	do	2+	6	2	—
11	do	4+	3	2	—
12	(?)[b]	4+	6	4	—
13	(?)[b]	4+	10	2	±
14	(?)[b]	4+	7	2	—

[a] Active lesions healed. [b] No clinical evidence of treponematous infection.

In twelve of these patients, including three of those in whom no definite clinical evidence of treponematous complications had been detected, the reaction became negative. In the other two it showed distinct diminution in strength; these were cases of yaws.

DISCUSSION

It has been recognized that the Kahn precipitation test has the same diagnostic value as has the Wassermann test in the serum diagnosis of syphilis, and Kolmer [10] has come to believe that the mechanism of the two reactions is probably essentially the same. It is reasonable, therefore, to expect that if leprosy per se were to give rise to the Wassermann reaction, as is believed by many, this reaction would also be positive, and would therefore be a valuable check on the former.

Our results are in conformity with those of Yagle and Kolmer, in that the Kahn precipitation reaction is consistently negative in uncomplicated leprosy. This is true even in cases suffering from lepra reaction, in which in some cases we obtained weakly positive Wassermann reactions. Therefore, we have further reason to believe that these reactions were not specific, but were due to errors inherent in the relatively complicated technic of the Wassermann reaction, coupled with unusual abnormalities

[10] Infection, Immunity and Biologic Therapy, 3d ed. Philadelphia, W. B. Saunders Co. (1923) 534.

of the serum in this peculiar condition. Obviously, sera of lepers have an increased tendency to fix complement, especially when a highly reënforced crude alcoholic antigen is used, though in the ordinary phases of the disease this can be overcome by the close adjustment of the various reagents used. That the weakly positive Wassermann reactions obtained by us in lepra reaction are due to this abnormal tendency of the serum and not to a true reagin production is indicated by the transitory character of such positive reactions and by the negative precipitation test. This is in keeping with the report of Clegg[11] that lepers in whom the Wassermann reaction was found positive gave negative luetin tests. Since the Kahn precipitation reaction is not influenced by this abnormality, we believe that it is of more value than the Wassermann for the detection of complicating yaws or syphilis in cases of leprosy.

That the positive reactions obtained were due to treponematous complications is indicated by the fact that there was clinical evidence of such infection in twenty-eight of the thirty-six cases that gave such results, and the further fact that neoarsphenamine treatment of several of those cases caused the clinical symptoms of treponematous complications to disappear, and in most cases caused the serological tests to become negative. The positive reactions in the eight cases not suspected of such complications we believe cannot be ascribed to leprosy. The clinical diagnosis could well have been missed; there was unusual probability of yaws infection in four (Moros); the reactions were strong except in a single case, with very slight leprosy but with scars, possibly of yaws; and, finally, treatment of three unselected individuals of this group changed the reaction to negative.

SUMMARY

Two hundred fifty sera from cases of leprosy were tested with the Kahn precipitation reaction. Two hundred fourteen were negative; thirty-six were positive in some degree, twenty-eight of whom were clinically positive for yaws or syphilis. Antitreponematous treatment of fourteen of the positive cases caused the reaction to become negative in twelve (including three of the eight cases that had given no distinct evidence of syphilis or yaws) and lessened the reaction in the other two. Fifty-four cases of lepra reaction are included in this series; all gave negative results.

[11] Pub. Health Bull. 61 (July, 1913) 11–14.

CONCLUSIONS

1. The Kahn precipitation reaction is negative in uncomplicated cases of leprosy.
2. It gives no doubtfully positive reaction in cases suffering from lepra reaction.
3. It is therefore preferable to the Wassermann reaction for the detection of complicating treponematous infections in lepers.
4. In leprosy there is no production of a reagin similar to that in yaws or syphilis.
5. Incidentally, the Kahn precipitation reaction has been found to be positive and to have the same value as the Wassermann reaction in the serum diagnosis of yaws.

ACKNOWLEDGMENTS

We are indebted to Dr. R. L. Kahn for supplying us with antigen and other material with which this work was started, and to Dr. H. W. Wade, chief pathologist of the Culion Leper Colony, for help in the preparation of this paper.

A NOTE ON THE PROBLEM OF PAINTING IPIL WOOD

By WALTER L. BROOKE

Chemist, Bureau of Science, Manila

INTRODUCTION

Ipil (*Intsia bijuga* O. Ktze.) is classified by the Bureau of Forestry as having durability I. It is one of the best structural timbers of the Philippine Islands. The universal disadvantage associated with its use is due to the coloring matter which the wood contains. The coloring matter is so easily soluble in water that during the rainy season it leaches from the wood and stains the surfaces over which the rain water containing it runs. Concrete pillars are stained at first a dirty red, later changing to an unsightly dark brown. Surfaces painted white are very badly discolored. The only reference in the literature to the coloring matter of ipil is by Brooks,[1] who states that—

> * * * The coloring matter reacts like a tannin, giving a black precipitate with ferric chloride and an abundant flocculent precipitate with gelatine solution. Owing to the limited supply of this wood and its value as building material, its virtues as a dye wood were not further investigated.

It is because of this troublesome coloring matter that the experiments here reported were undertaken.

Ipil wood was formerly exported to Holland in considerable quantities, but for what particular purpose I was not able to learn from any book or periodical now in the Bureau of Science library.

The nature of the coloring matter.—One of the most characteristic things about a piece of ipil is the small yellow deposits in the pores. They have been described as sulphur yellow deposits. This yellow substance is easily extracted from the wood or the sawdust by ether or chloroform. It is insoluble in water and has nothing to do with the red coloring matter of the wood. It is undoubtedly a wood resin or wax. It is soluble in carbon bisulphide, benzene, and absolute alcohol, but only partly so in acetone. A chloroform solution has no rotary power. The

[1] Philip. Journ. Sci. § A 5 (1910) 447.

substance melts, darkens in color, gives off a characteristic odor, and burns with a smoky flame but leaves no ash. Toward litmus paper it is very slightly acid. The chloroform and the ether solutions are both yellow, but wool is not dyed by an acid ether-chloroform solution. Four hundred twenty grams of ipil sawdust gave 2.65 grams of the yellow substance when extracted in a Soxhlet apparatus with chloroform. This corresponds to a yield of 0.64 per cent. Cold ether dissolves the yellow substance from the extracted material and leaves behind a whitish waxlike residue.

The red coloring matter, which discolors the painted wood, is a tannin of the phlobatannin class. A solution of the red coloring matter yields a precipitate with tin, iron, zinc, copper, and lead salts. With ferric chloride, it gives a greenish coloration, then a blackish precipitate. The precipitate formed with basic lead acetate is soluble in dilute acetic acid. Bromine yields a precipitate. The formaldehyde-hydrochloric acid test indicates that it is a catechol tannin. When the tannin solution is coupled with diazotised aniline, a brownish dye is formed. A precipitate is produced if the tan liquor is allowed to stand with a solution of aniline hydrochloride.

When four blocks 4.5 by 2 by 5 centimeters, weighing approximately 180 grams, had been soaked twenty-four hours in 500 cubic centimeters of distilled water, the tannin solution decanted from the blocks, diluted to 500 cubic centimeters in a standard flask, heated to 80° C., cooled to room temperature, and the tannin determined by the method of the American Leather Chemists' Association, the results shown in Table 1 were obtained.

TABLE 1.—*Results of soaking experiments with ipil.*

Experiment No.	Number of blocks.	Weight.	Time of soaking.	Tan liquor diluted to.	Soluble solids in liquor.	Non-tannin.	Tannin in liquor.	Tannin extracted.
		g.	*Hrs.days.*	*cc.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	4	185	24	500	0.502	0.159	0.343	0.927
2	4	188	24	500	0.510	0.161	0.349	0.928
3	4	174	5	500	1.041	0.338	0.703	2.08
4	4	174	5	500	1.034	0.343	0.691	1.87

These quantitative results support a rough qualitative experiment in which some ipil sawdust was placed in a test tube, twice the volume of distilled water added, vigorously shaken, and then filtered. Twice the volume of distilled water was then

added, and the mixture was shaken and filtered. This operation was repeated twice more. If a value of 100 be assigned to the color of the sawdust, then the aqueous extracts could be represented by the following values: No. 1, 200; No. 2, 90; No. 3, 45; and No. 4, 30.

The tan liquor is darkened by making the solution alkaline, but the color is lightened again by acidification. The stains produced on concrete are readily explained when one remembers that concrete in "setting" liberates large quantities of calcium hydroxide.

The best way to prevent the leaching of ipil wood is to remove the tannin entirely, or at least to the extent that the paints used will have sufficient covering power to hold back the residual coloring matter; or to devise a paint that is impervious to water.

RESULTS OF EXPERIMENTS

All of the experiments here discussed were conducted on small blocks of wood, such as were used for the tannin determinations. Since a very large precipitate was formed with an iron sulphate or a gelatine solution, an attempt was made to close the pores by soaking the wood in these solutions. The precipitate that formed closed the pores fairly well, but some of the precipitate remained adhering to the wood so that, before painting, it was necessary to brush the surface of the lumber with a strong bristle brush to remove the precipitate to avoid the peeling of the paint after it was applied. This procedure was considered too expensive for practical work.

Many experiments were tried with brea, shellac, rosin, resinates, copal, and dammar resins, using amyl alcohol, amyl acetate, acetone, alcohol, benzene, gasoline, and ethyl acetate as solvents. Brea and rosin yielded a varnish less sticky than a pure brea varnish and not so brittle as a straight rosin varnish, but it tended to swell and whiten when soaked in water.

Fine aluminum powder mixed with white lead paint improved the covering power of the paint much more than when mixed with a red lead or a lithopone-calcium carbonate paint. The best single paint was red lead paint (75 grams red lead with 25 grams boiled linseed oil). Two coats of this paint proved entirely satisfactory.

Painting the wood with a dilute solution of iron sulphate, allowing this to dry, and then painting in the regular way, increased the covering power of the paint considerably. It was better than a dilute solution of aniline hydrochloride. A 10 per

cent solution of paraffine in kerosene was less efficient than a dilute solution of aniline hydrochloride. A paint composed of two pigments was found to be better than the use of each one separately would indicate.

Many things aid a paint to hold in the coloring matter. One substance will not aid different paints to the same degree. Dr. T. Dar Juan, a chemist of the Bureau of Science, tried the iron sulphate treatment on his residence in 1919, and he reports it to be entirely satisfactory. Many formulas will no doubt be suggested for painting ipil wood, but all must depend on being water-tight or on precipitating the tannin if the wood is unleached wood. Painting the wood with lead acetate solution is also effective, but is more expensive than the iron sulphate treatment.

RECOMMENDATIONS

The following recommendations are offered:

1. Leach the wood, if possible, by allowing it to remain in a stream for several days or by allowing it to pass through a rainy season uniformly exposed or already erected.
2. Paint with a dilute aqueous solution of iron sulphate (about 4 per cent).
3. Paint, if possible, with an undercoat of red lead paint, using 75 parts pigment to 25 parts by weight of boiled linseed oil.
4. Try to use a mixture of pigments instead of only one pigment in the paint. This does not mean, however, that a pigment of good covering power should be used with one of poor covering power.
5. Be sure to paint the surface uniformly, being especially careful about cracks. Joints should be painted at the time of erection.

THE VITAMIN B CONTENT OF SOME PHILIPPINE FRUITS AND VEGETABLES, II [1]

By F. O. SANTOS and S. SANTOS

Of the College of Agriculture, University of the Philippines, Los Baños

THREE TEXT FIGURES

INTRODUCTION

The prevention of beriberi is still an unsolved problem. Based on our present knowledge of the disease, two possible methods of solution present themselves; namely, the enactment of legislation prohibiting the polishing of rice, and the education of the people as to proper food selection.

The solution by legislation will meet two important obstacles which are difficult to surmount; namely, the people are already accustomed to eating polished rice and unpolished rice does not look appetizing, and the rice merchants are unwilling to carry unpolished rice in stock because it is believed to deteriorate easily. The experiments on the keeping quality of unpolished rice that are being conducted in this laboratory seem to show that it really can not be kept as long as can polished rice. Furthermore, merchants are unwilling to carry unhusked rice, because of the added transportation expenses entailed and the increased storage facilities that would be required.

The solution by education is slow, but at the same time sure. It is the method advocated by the Far Eastern Association of Tropical Medicine (1923). There are schools in every barrio in the Philippines. By proper direction, instruction in adequate food selection can be given in the schools. The Bureau of Agriculture, the Bureau of Health, and the Public Welfare Commissioner can all lend a helping hand in bringing this about.

However, before proper food selection can be successfully taught, it is necessary that the food values of the available materials be known. Our experience in the laboratory has shown that some fruits and vegetables, generally considered to

[1] Experiment Station contribution No. 358. Published with the permission of the Director of the Experiment Station at Los Baños.

be good sources of vitamin B, are poor in this essential. Further, it is generally accepted that beriberi is due, either directly or indirectly, to the lack of vitamin B in the diet or to an infection by some organism made possible by the deficiency of this vitamin. In view of these facts, it seems highly desirable to test further for the presence of this food factor in Philippine food materials.

This paper is the second report on the determination of vitamin B content of Philippine fruits and vegetables. All of the work was done in the College of Agriculture, from July 18, 1923, to January 20, 1925.

Some of the food materials that are used in the United States and in Europe are also used in the Philippines. Their vitamin B content is given by Sherman and Smith.(10) The following Philippine food materials have also been tested for vitamin B:

By Santos:(8) Mungo (*Phaseolus mungo* Linnæus), togi (sprouted mungo); okra [*Abelmoschus esculentus* (Linnæus) Moench]; avocado (*Persea gratissima* Gaertner); bamboo shoots (*Bambusa* sp.); sweet potato leaves [*Ipomœa batatas* (Linnæus) Poir.]; duhat (*Eugenia jambolana* Lam.); artichokes (*Cynara scolymus*); bilimbi (*Averrhoa carambola* Linnæus); and banana flower bud (*Musa sapientum* Linnæus).

By Derecho:(2) Copra meal.

By Acuña:(1) Paayap (*Vigna sinensis* Linnæus); banana; papaya (*Carica papaya* Linnæus); and paco (*Ethyrium esculentum*).

MATERIALS AND METHODS

The biological method, generally accepted for the determination of vitamin B, was used.(10) The qualitative test recently reported by Jendrassik(4) was also used in this work.

THE FEED

Basal diet.—The basal diet had the following ingredients: Corn starch, 64 grams; casein, 18; butter fat, 9; lard, 3; salt mixture, 4; and filter paper, 2.

"Liberty" brand corn starch, which is obtainable in the local market, was used. The casein, imported from Merk and Company, was ground into powder and washed five times with rain water. The filter paper was soaked in water, macerated, ground in a meat grinder, and then dried in the sun. The butter fat was prepared from Golden State butter.

The salt mixture had the following composition:(5) Sodium chloride, 5 grams; potassium biphosphate, 12.1; primary calcium phosphate (monohydrate), 2.56; calcium lactate, 29.44; and iron citrate, 1.

Supplements to basal diet.—The vegetables used in this investigation were paco (*Diplazium esculentum* Swartz); balunsay (*Celosia argentea* Linnæus); and uray babae (*Amaranthus viridis* Linnæus).

The chemical analyses of these vegetables are presented in Table 1.

TABLE 1.—*Chemical analyses* [a] *of vegetables used in the experiment.*

Vegetable.	Moisture.	Fat.	Ash.	Protein.	Crude fiber.	Carbohydrates.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Paco	89.98	2.62	1.36	3.51	1.08	1.45
Balunsay	89.23	0.52	1.67	3.22	1.47	3.89
Uray babae	78.89	0.78	3.55	6.24	1.47	9.07

[a] By Chemistry Department, College of Agriculture, Los Baños.

In preparing the supplements the plants were dried in the sun. After drying they were ground fine through a meat grinder.

In the latter part of the experiment the supplements were extracted according to the method of Susuki, Shimamura, and Odake.(11)

Control sources of vitamin B.—Three control sources of vitamin B were used; namely, yeast, tikitiki,(9) and camote leaves.(8) Tikitiki, furnished by the Bureau of Science, Manila, was used in quantities of 0.5 cubic centimeter and 1 cubic centimeter. One tablet (0.2 gram) of Harris yeast vitamin, prepared according to the method of Osborne and Wakeman,(6) was given daily to animals under treatment. The camote leaves were dried in the sun and then ground fine. One gram of this food was given, and toward the close of the experiment the ration was increased to 2 grams.

EXPERIMENTAL ANIMALS

White rats were used as the experimental animals. Healthy ones were selected, and they were kept in separate cages. They were divided into three groups, one group for each supplement to be tested.

FEEDING TECHNIC

The feeding technic was essentially the same as that reported by Ferry.(3) The experimental animals were first given a basal diet deficient in vitamin B. When they had declined in weight to a point where they looked physically weak, known quantities of the materials that were being tested were given as daily supplement to the basal ration. If on the supposedly corrected feed no improvement in the weight and appearance of the animals was noticed, the daily supplement was replaced by known rich sources of vitamin B. This was done to show that the real cause in the further decline of the animal was due to lack of vitamin B in the material that was being tested, and not to other causes. Sometimes healthy animals were given the basal ration plus the material under investigation at the commencement of the experiment, and the change in weight noted.

Records of basal food intake and body weights were taken twice a week.

Either rain water or boiled water was given to the animals, ad libitum.

EXPERIMENT AND RESULTS

Protocols of body weight and food intake are given in Tables 2, 3, and 4. The body weights of some of the rats are also presented graphically in figs. 1, 2, and 3. The behavior of the individual animals is described in detail in the Appendix.

In the tables the letters y, x, xx, and z precede some of the weight figures, and are to be interpreted thus:

y, basal ration alone.
x, basal ration plus 1 gram supplement.
xx, basal ration plus extract corresponding to 2 grams supplement.
z, basal ration plus control source of vitamin B.

KEY TO TEXT FIGURES

y ————, basal ration alone.
x— — —, basal ration plus 1 gram supplement.
xx, — — — —, basal ration plus extract corresponding to 2 grams supplement.
z — - — - —, basal ration plus control source of vitamin B.
○, beginning in change of ration.

FEEDING TESTS

Paco.—The four animals (Nos. 1, 2, 3, and 4) given this food continued to decrease in weight when this supplement was added to the basal diet. All except rat 1, which died early, were put to the test more than once, and always failed to increase in weight. (See Table 2 and fig. 1.) Even with amounts corre-

TABLE 2.—*Paco: Body weight and biweekly intake of basal ration.*

Date.	Body weight.	Intake of basal ration.
RAT 1 ♂.		
1923	*Grams.*	*Grams.*
July 18	120	--------
July 31	106	98
August 14	100	54
August 28	98	81
September 11	126	115
September 25	142	128
October 9	125	73
October 23	103	50
November 6	x93	59
November 20	84	48
December 4	81	49
December 6	([a])	--------
RAT 2 ♀.		
1924		
April 12	117	--------
April 26	108	65
May 10	103	68
May 24	x93	79
June 7	z72	50
June 21	94	84
July 1	y94	--------
July 5	92	39
July 19	z96	50
August 2	170	120
August 9	x185	--------
August 16	191	99
August 30	131	53
September 9	z106	--------
September 13	111	40
September 27	150	110
October 11	187	97
October 25	200	126
November 8	y206	129
November 22	170	87
November 29	xx147	--------
December 6	z124	46
December 20	193	140
1925		
January 3	208	156
January 17	235	165
RAT 3 ♂.		
1924		
July 22	z93	--------
July 29	129	73

Date.	Body weight.	Intake of basal ration.
RAT 3 ♂.		
1924	*Grams.*	*Grams.*
August 12	x163	115
August 26	144	70
September 9	129	67
September 23	z115	72
October 7	131	120
October 21	y172	134
November 1	xx169	--------
November 4	170	99
November 18	149	117
December 2	110	49
December 6	z109	--------
December 16	132	116
December 30	157	140
1925		
January 13	199	161
January 20	203	--------
RAT 4 ♂.		
1924		
March 22	88	--------
April 5	76	48
April 19	x61	36
May 3	53	44
May 6	z53	--------
May 17	62	60
May 30	78	73
June 14	y80	59
June 28	x74	45
July 12	z57	52
July 26	110	97
August 9	x150	130
August 23	142	82
September 6	z106	45
September 20	122	97
October 4	159	86
October 18	166	98
November 1	171	117
November 15	xx175	120
November 29	z137	72
December 13	141	193
December 27	165	145
1925		
January 10	200	128
January 20	203	--------

[a] Died.

sponding to 2 grams dry weight the animals did not improve. This shows that paco is deficient in vitamin B for the growth of rats.

Balunsay.—The result with balunsay was practically the same as that with paco. The noticeable difference between the two is that two of the animals (Nos. 7 and 8) treated with balunsay maintained their weights for a longer time than did the animals treated with paco, before signs of weakness were observed. (See Table 3 and fig. 2.) This result seems to indicate that balunsay contains some vitamin B, but the amount used was probably enough for maintenance only and not for growth. This statement is supported by the result of the color test.

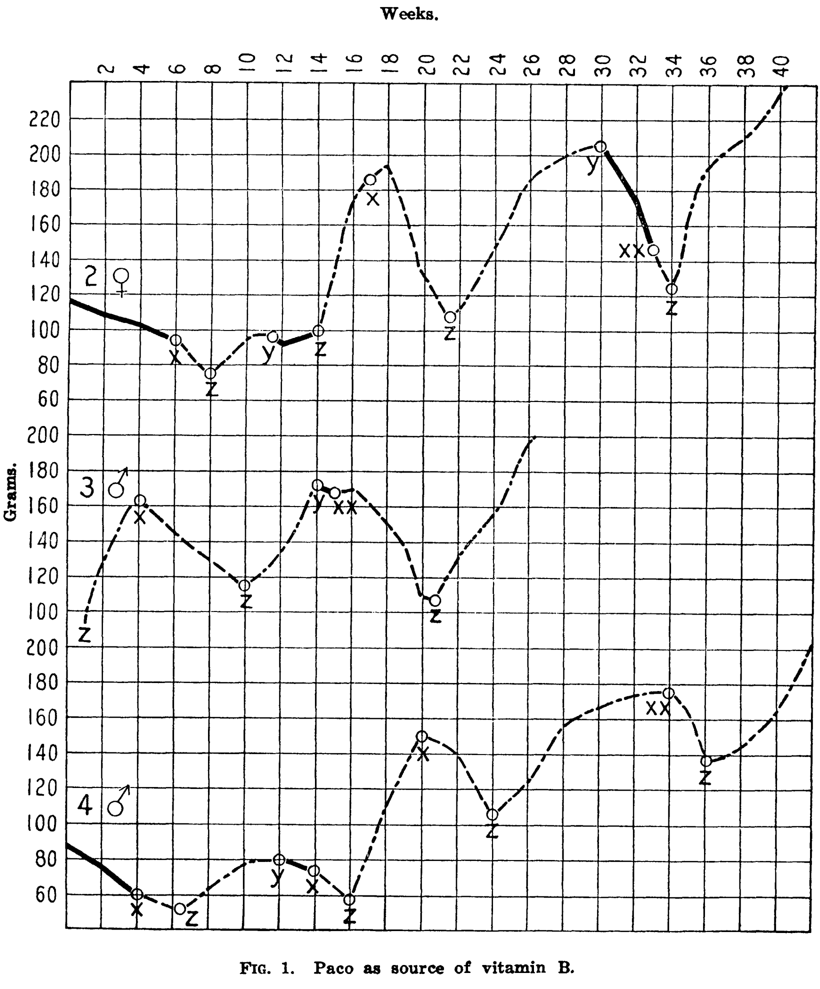


FIG. 1. Paco as source of vitamin B.

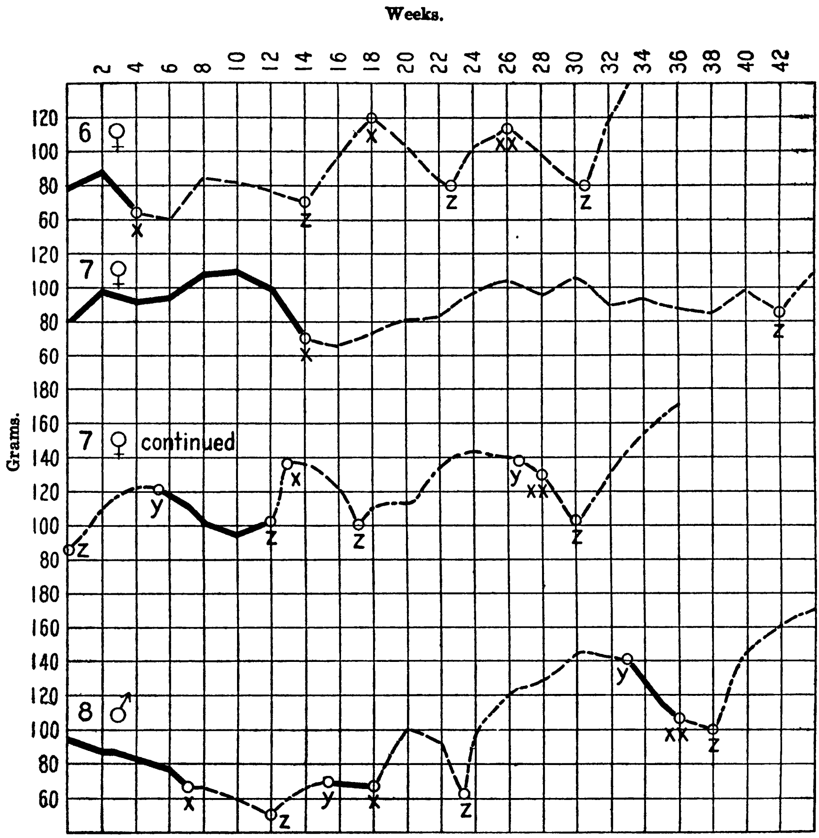


FIG. 2. Balunsay as source of vitamin B.

TABLE 3.—*Balunsay: Body weight and biweekly intake of basal ration.*

RAT 5 ♂.			RAT 5 ♂.		
Date.	Body weight.	Intake of basal ration.	Date.	Body weight.	Intake of basal ration.
1923	*Grams.*	*Grams.*	**1924**	*Grams.*	*Grams.*
July 21	96	--------	January 5	86	62
August 4	109	101	January 19	79	57
August 18	106	90	February 2	73	55
August 31	111	96	February 16	81	49
September 15	123	89	March 1	97	80
September 29	129	104	March 15	95	79
October 13	116	81	March 29	88	83
October 27	x95	39	April 12	90	82
November 10	74	22	April 26	95	50
November 24	76	37	May 10	81	56
December 8	84	42	May 24	87	64
December 22	85	51	May 27	z68	--------

TABLE 3.—*Balunsay: Body weight and biweekly intake of basal ration*—Continued.

RAT 5 ♂.

Date.	Body weight.	Intake of basal ration.
1924	*Grams.*	*Grams.*
June 7	108	93
June 17	y113	--------
June 21	105	80
July 5	92	62
July 12	x86	--------
July 19	73	63
July 21	([a])	--------

RAT 6 ♀.

Date.	Body weight.	Intake of basal ration.
1924		
June 3	77	--------
June 17	88	66
July 1	x64	25
July 15	61	51
July 29	85	49
August 12	82	87
August 26	78	54
September 9	z70	61
September 23	97	107
October 7	x120	71
October 21	104	50
November 4	80	65
November 8	z80	--------
November 18	104	112
December 2	xx113	141
December 16	98	63
December 30	80	92
1925		
January 3	z80	--------
January 13	122	118
January 20	135	--------

RAT 7 ♀.

Date.	Body weight.	Intake of basal ration.
1923	*Grams.*	*Grams.*
July 21	80	--------
August 4	97	92
August 18	92	93
August 31	93	77
September 15	107	98
September 29	109	81
October 13	99	57
October 27	x70	34
November 10	65	34
November 24	73	40
December 8	80	51
December 22	82	46
1924		
January 5	96	45
January 19	103	87
February 2	97	61
February 16	105	61
March 1	90	89
March 15	93	77
March 29	88	68
April 12	85	92
April 26	96	66
May 10	z86	57
May 24	110	108
June 7	122	90
June 17	y122	--------
June 21	120	82
July 5	104	36
July 19	94	65
August 2	z102	62
August 12	x137	--------
August 16	137	180
August 30	121	100
September 9	z100	--------
September 13	113	57
September 27	115	100
October 11	135	77
October 25	142	116
November 8	138	106
November 11	y137	--------
November 22	xx130	89
December 6	z103	113
December 20	132	103
1925		
January 3	155	157
January 17	170	133

RAT 8 ♂.

Date.	Body weight.	Intake of basal ration.
1924		
March 15	96	--------
March 29	88	82
April 12	84	81
April 26	77	40

[a] Died.

TABLE 3.—*Balunsay: Body weight and biweekly intake of basal ration*—Continued.

RAT 8 ♂.			RAT 8 ♂.		
Date.	Body weight.	Intake of basal ration.	Date.	Body weight.	Intake of basal ration.
1924	*Grams.*	*Grams.*	1924	*Grams.*	*Grams.*
May 3	x68		September 27	128	91
May 10	65	41	October 11	143	93
May 24	60	49	October 25	141	97
June 7	z51	45	November 1	y142	
June 21	67	46	November 8	130	87
July 1	y70		November 22	xx108	58
July 5	69	39	December 6	z100	69
July 19	x68	53	December 20	144	56
August 2	100	43			
August 16	90	61	1925		
August 26	z63		January 3	161	146
August 30	96	81	January 17	170	111
September 13	122	59	January 20	172	

Uray babae.—When this supplement was added to the basal diet animals Nos. 9, 10, 11, and 12 continued to decrease in weight. Table 4 and fig. 3 show that the animals on this sup-

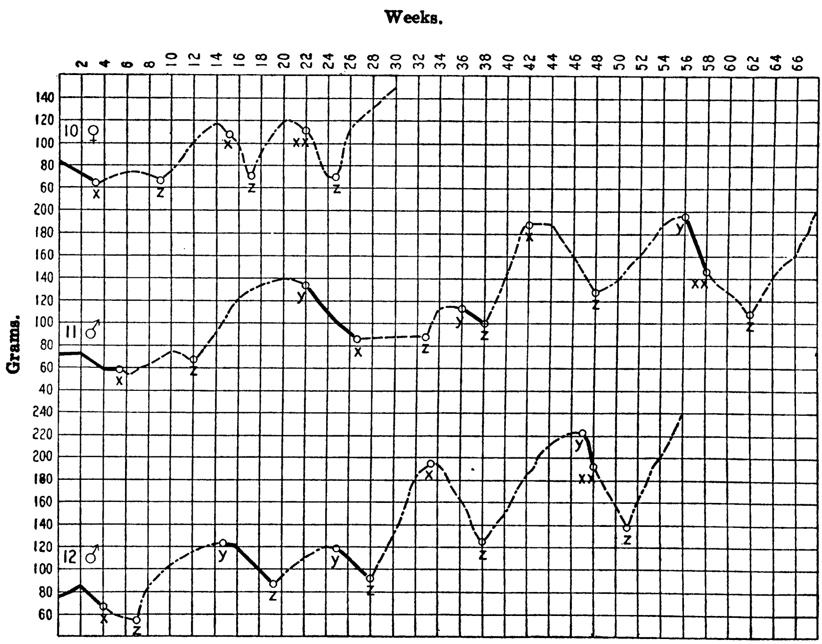


FIG. 3. Uray babae as source of vitamin B.

plement could not maintain their weights for any great length of time. They did not improve even with the administration of extract corresponding to 2 grams dry weight. The results of the color test also showed that uray is poor in vitamin B.

TABLE 4.—*Uray babae: Body weight and biweekly intake of basal ration.*

RAT 9 ♂.		
Date.	Body weight.	Intake of basal ration.
1923	*Grams.*	*Grams.*
July 18	y105	-------
July 31	100	106
August 14	90	71
August 28	97	94
September 11	113	127
September 25	121	106
October 9	133	127
October 23	108	64
November 6	105	93
November 20	112	117
December 4	109	108
December 8	x109	-------
December 18	105	82
December 22	z95	-------
1924		
January 1	136	140
January 15	164	163
January 29	150	111
February 12	167	124
February 22	177	163
March 11	168	151
March 25	y173	143
April 8	159	126
April 22	130	97
May 3	x108	-------
May 6	z100	88
May 20	128	119
June 3	151	147
June 7	y151	-------
June 17	126	55
July 1	109	60
July 8	80	28
	(a)	-------

RAT 10 ♀.		
Date.	Body weight.	Intake of basal ration.
1924	*Grams.*	*Grams.*
June 17	y83	-------
July 1	72	63
July 12	x64	-------
July 15	65	52
July 29	72	37
August 12	72	60
August 19	z66	-------
August 26	73	53
September 9	98	127
September 23	115	92
October 4	x109	-------
October 7	100	68
October 18	z72	-------
October 21	90	35
November 4	118	132
November 18	xx111	106
December 2	69	111
December 6	z69	-------
December 16	110	105
December 31	130	136
1925		
January 13	150	102
January 20	152	201

RAT 11 ♂.		
Date.	Body weight.	Intake of basal ration.
1923		
October 30	y72	-------
November 13	72	65
November 27	59	44
December 8	x59	-------
December 11	55	98
December 25	64	42
1924		
January 8	73	60
January 22	z68	64
February 5	91	80
February 19	123	108
March 4	132	108
March 18	137	126
April 1	y134	88
April 15	111	66
April 29	90	53
May 3	x86	-------

[a] Died.

TABLE 4.—*Uray babae: Body weight and biweekly intake of basal ration*—Continued.

RAT 11 ♂.

Date.	Body weight.	Intake of basal ration.
1924	*Grams.*	*Grams.*
May 13	86	71
May 27	87	64
May 31	z87	--------
June 10	112	86
June 24	y113	78
July 8	z100	61
July 22	143	120
August 5	x188	129
August 19	188	117
September 2	161	78
September 16	z126	72
September 30	137	102
October 14	160	121
October 28	187	127
November 11	y196	136
November 25	xx145	56
December 9	130	63
December 13	z109	--------
December 23	142	135
1925		
January 6	160	148
January 20	201	130

RAT 12 ♂.

Date.	Body weight.	Intake of basal ration.
1923		
December 22	y75	--------
1924		
January 5	85	57
January 19	x67	58
February 2	58	53
February 9	z56	--------
February 16	86	93
March 1	103	74
March 15	115	103
March 29	121	147
April 5	y124	--------
April 12	118	111
April 26	100	38
May 6	z86	--------
May 10	94	51
May 24	111	111
June 7	120	83
June 14	y118	--------
June 21	110	50
July 5	z92	50
July 19	131	116
August 2	183	125
August 12	x195	--------
August 16	196	110
August 30	163	82
September 13	z125	53
September 28	148	106
October 11	186	102
October 25	210	152
November 8	221	118
November 11	y224	--------
November 22	xx192	96
December 6	157	46
December 13	z137	--------
December 20	160	77
1925		
January 3	200	133
January 17	243	143
January 20	247	--------

COLOR TEST

The method of Jendrassik (4) for qualitative test for vitamin B was followed. To the solution of the extracts used, a 2 per cent solution of acetic acid was added. The reagent, which consisted of equal volumes of tenth molar ferric chloride and potassium ferric cyanide solutions, was added to this solution of the extracts as long as the blue color increased. The test tubes containing the mixture were stoppered and allowed to

stand for ten minutes. One volume of distilled water was added and the color produced was observed.

The results of the color test were as follows:

Paco showed only a trace of blue color.

Balunsay showed some blue coloration.

Uray showed blue color but of a lighter shade than that produced by balunsay.

All the colors produced were less intense than were those produced by the corresponding amount of yeast extract.

CONCLUSIONS

Paco was found to be a poor source of vitamin B. Alcoholic extract corresponding to 2 grams of dried material, when added to a basal ration, was not enough to support the growth of rats.

Balunsay in the amount of 1 to 2 grams contains some vitamin B which could maintain the weight of the rats for some time.

Uray babae, like paco, contains a negligible amount of vitamin B. When an extract corresponding to 2 grams dry weight was used as supplement, the animals failed to grow.

LITERATURE CITED

1. ACUÑA, E. The vitamin B content of some Philippine fruits and vegetables. Philip. Agr. 12 (1923) 293–302.
2. DERECHO, A. A biological study of copra. Philip. Agr. 10 (1921) 45–54.
3. FERRY, E. N. Nutrition experiments with rats. A description of method and technique. Journ. Lab. & Clinic. Med. 5 (1920) 735–745.
4. JENDRASSIK, A. A color test for water soluble B. Journ. Biol. Chem. 7 (1923) 129–138.
5. MCCOLLUM, E. V., and M. DAVIS. The nature of dietary deficiencies of rice. Journ. Biol. Chem. 33 (1915) 181–230.
6. OSBORNE, T. B., and A. J. WAKEMAN. Extraction and concentration of the water-soluble vitamin from brewers' yeast. Journ. Biol. Chem. 40 (1919) 383–394.
7. Report of the Fifth Congress of the Far Eastern Assoc. Trop. Med. (1923) 90. Singapore.
8. SANTOS, F. O. Some plant sources of vitamin B and C. Am. Journ. Physiol. 59 (1922) 310–334.
9. SANTOS, F. O., and E. G. COLLADO. Vitamin B in tikitiki extract prepared by the Philippine Bureau of Science. Philip. Agr. 14 (1925) 243–245.
10. SHERMAN, H. C., and S. L. SMITH. The vitamins. Am. Chem. Soc. Monog. Ser. New York (1922) 273.
11. SUSUKI, U., T. SHIMAMURA, and S. ODAKE. Oryzanin, ein Bestandteil der Reiskleie und seine physiologische Bedeutung. Biochem. Zeitsch. 43 (1912) 89–153.

APPENDIX

DETAILED DESCRIPTION OF THE BEHAVIOR OF THE INDIVIDUAL RATS

Paco as source of vitamin B.—Rat 1 ♂, weighing 120 grams, was given the basal diet alone from July 18 to November 6, 1923, at which time the animal weighed 93 grams. From this time on 1 gram of the supplement was given daily. On December 4, 1923, this animal was observed to be weak and it died two days later.

Rat 2 ♀, on April 12, 1924, was placed on the basal diet until May 24, 1924, when its weight was only 93 grams. From this time on 1 gram of paco was given until June 7, 1924, when the animal showed signs of weakness and weighed only 72 grams. Then 1 cubic centimeter tikitiki was given daily. The tikitiki supply was exhausted on July 1, 1924, and so the animal was placed again on the basal diet alone until July 19. Then yeast was administered until August 9, 1924, when the animal attained a weight of 185 grams. From this date on 1 gram of paco was given until September 9, 1924, when the weight had decreased to 106 grams and signs of weakness were observed. Then 1 gram camote was given until November 8, 1924, when the weight of the rat was 206 grams. The animal was again placed on the basal ration alone. On November 29 the weight was found to be 147 grams only, and from this date paco extract corresponding to 2 grams dry weight was given in addition until December 6, 1924. In spite of the increase in supplement, this animal decreased in weight to 124 grams, so from this time it was given camote. On camote as supplement the rat increased in weight to 235 grams.

Rat 3 ♂ was first placed on the basal diet plus yeast beginning July 22, 1924. On this ration it increased from 93 to 163 grams in weight. One gram paco was substituted for the yeast until September 23, 1924, when the animal weighed 115 grams. From this date camote was given instead of paco until October 21, 1924, when the animal had attained a weight of 172 grams. The camote was cut off then, and the basal diet alone was given until November 1, 1924, when the weight had decreased to 169 grams. Then extract corresponding to 2 grams dry weight of paco was given in addition to the basal ration. In spite of the increase in supplement the animal decreased in weight; so 1 gram camote leaves was again given instead of the supplement in question, and the animal attained a weight of 203 grams.

Rat 4 ♂, with an initial weight of 88 grams, was placed on basal ration alone from March 22 until April 19, 1924, when the weight had decreased to 61 grams, and then 1 gram paco was given as supplement. This treatment was continued until May 6, 1924, when the weight was only 53 grams and signs of weakness were observed. Then 0.5 cubic centimeter tikitiki was given daily instead of paco until June 14, 1924, when this animal had attained a weight of 80 grams. As the supply of tikitiki was exhausted, the animal was placed on basal diet alone until June 28, 1924, when it weighed 74 grams. Then 1 gram paco was given again until July 12, 1924, and its weight continuously decreased to 57 grams and signs of weakness were again observed. From this time yeast was given instead of paco and the rat, on August 9, 1924, was found to weigh 150 grams. Paco was again given instead of yeast until September 6, 1924, when the weight had decreased to 106 grams. Then 1 gram camote

was given until November 15, 1924, when the weight had increased to 175 grams. Paco extract corresponding to 2 grams dry weight was given instead of camote until November 29, 1924, when the animal weighed only 137 grams and had weakened, as before. From this time camote was repeated until the rat attained a weight of 203 grams.

Balunsay as source of vitamin B.—Rat 5 ♂, with a weight of 96 grams, was given basal ration alone from July 21 until October 27, 1923, when the weight was 95 grams. Then 1 gram balunsay was given daily until May 27, 1924, when the weight had decreased to 68 grams and signs of weakness were marked. From this date 0.5 cubic centimeter tikitiki was given instead of balunsay until June 17, 1924, when the weight had increased to 113 grams. The supply of tikitiki having become exhausted, from this time only basal ration was given until July 12, 1924, when the rat had fallen in weight to 86 grams. Balunsay was then again added to its basal ration and on July 19, 1924, the animal was observed to be very weak and to weigh only 73 grams. Two days later it died.

Rat 6 ♀, weighing 77 grams, was placed on basal ration from June 3 to July 1, 1924, when its weight had decreased to 64 grams. From this time 1 gram balunsay was added to the basal diet until September 9, 1924, when the rat weighed only 70 grams and signs of weakness were observed. Then 1 gram camote was given instead of balunsay until October 7, 1924, when the rat weighed 120 grams. From this date the camote supplement was cut off and 1 gram balunsay was given daily, instead, until November 8, 1924, when the weight had decreased to 80 grams. Again 1 gram camote was given until December 2, 1924, when the body weight had increased to 113 grams. From this time camote was cut off and, instead, alcoholic extract of balunsay corresponding to 2 grams dry weight was administered until January 3, 1925, when the animal was observed to be very weak and to weigh only 80 grams. The camote was given again until full recovery was observed and the animal weighed 135 grams.

Rat 7 ♀, with an initial weight of 80 grams, was placed on basal ration alone from July 21 to October 27, 1923, when the weight had decreased to 70 grams. From this date 1 gram balunsay as supplement was added daily to the diet until May 10, 1924, when the body weight was 86 grams. At this time signs of weakness were observed and so tikitiki was given, instead, until June 17, 1924, when the weight had increased to 122 grams. Then, the supply of tikitiki being exhausted, basal diet alone was given until August 2, 1924, when the rat was found to be weak and to weigh 102 grams. Then one pill yeast was given daily until August 12, 1924, when a weight of 137 grams had been attained; then the yeast was discontinued and 1 gram balunsay was given until September 9, 1924, when this rat had decreased in weight to 100 grams and signs of weakness were evident. One gram camote as supplement was given, instead of balunsay, until November 11, 1924, when the weight had increased to 137 grams. Then the supply of camote was cut off, and on November 22, when the weight was 130 grams, balunsay extract corresponding to 2 grams dry weight was given. On December 6, 1924, the animal weighed only 103 grams and was very weak. From this date camote was given until the animal attained a weight of 170 grams.

Rat 8 ♂, on March 15, 1924, with a body weight of 96 grams, was placed on the basal ration until May 3, 1924, when the weight had decreased to

68 grams. From this time 1 gram balunsay was given daily until June 7, 1924, when it weighed only 51 grams and was hardly able to move. Tikitiki then was given as supplement instead of balunsay. The tikitiki supply, however, was exhausted by July 1, 1924, and only basal diet was given until July 19, when the weight had fallen to 68 grams. One gram balunsay was again administered until August 26, 1924, when the weight had further decreased to 63 grams and the animal was very weak. Camote was given from this time until November 1, 1924, when it had increased in weight to 142 grams. The camote supply was cut off and only basal ration was given until November 22, 1924, when the weight had again decreased to 108 grams. From this time balunsay extract corresponding to 2 grams dry weight was administered to the animal until December 6, 1924, when the body weight had further decreased to 100 grams. The animal showed signs of sluggish motion and in this condition camote was given. This treatment continued until a weight of 172 grams was attained by the rat.

Uray babae as source of vitamin B.—Rat 9 ♂, with an initial weight of 105 grams, was given basal ration alone until December 8, 1923, when the weight was 109 grams. From this time 1 gram uray was added to the ration daily until December 22, 1923, when signs of weakness were observed and its weight had decreased to 95 grams. Then tikitiki was given, instead, until March 25, 1924, when full recovery was observed and the animal had attained a weight of 173 grams. From this time tikitiki was cut off until May 3, 1924, when the weight had decreased to 108 grams, and then 1 gram uray was given again. Three days later the rat was observed to be sick and it weighed only 100 grams; so tikitiki was administered until June 7, 1924, when it had attained a weight of 151 grams. Tikitiki was cut off again and only basal ration was given until July 8, 1924, when the animal died.

Rat 10 ♀, with its initial weight of 83 grams, was placed on basal ration alone from June 17 to July 12, 1924, when its weight had decreased to 64 grams, and then 1 gram uray was added daily until August 19, 1924. On this date the rat was found to be weak, and it weighed only 66 grams; so 1 gram camote was given instead of the supplement uray. On October 4, 1924, the animal weighed 109 grams, and from this date 1 gram uray was given again instead of camote. By October 18 the animal had again become weak and its weight had decreased to 72 grams. Again camote was given until November 18, 1924, when its weight was 111 grams. Then uray extract, corresponding to 2 grams dry weight, was administered until the weight had decreased to 69 grams and signs of weakness were observed. Instead of the supplement uray, camote was given until the rat fully recovered and attained a weight of 152 grams.

Rat 11 ♂, with an initial weight of 72 grams, was given basal diet alone from October 30 to December 8, 1923, when the weight was only 59 grams. Then 1 gram uray was added to the basal ration until January 22, 1924, when the rat had a weight of 68 grams. Tikitiki was given instead of uray until April 1, 1924, when the rat had attained a weight of 134 grams. Only basal ration was then given and on May 3, 1924, the body weight was found to be 86 grams. Then 1 gram uray was administered until May 31, when the animal was observed to be weak and to weigh 87 grams. One cubic centimeter of tikitiki was given daily until

June 24, 1924, when the rat weighed 113 grams. On July 8, 1924, the animal weighed only 100 grams, and yeast (one pill daily) was given until August 5, 1924, when the weight had increased to 188 grams. One gram of uray was substituted for the yeast until September 16, 1924, when the rat had a weight of 126 grams and was in sluggish condition. Then camote was given until November 11, 1924, when a weight of 196 grams had been attained. This treatment was cut off, and on November 25 the weight had decreased to 145 grams. From this time uray extract corresponding to 2 grams dry weight was given, but in spite of this treatment the rat became weak and it decreased in weight to 109 grams by December 13, 1924. Then camote was given until the weight had increased to 201 grams.

Rat 12 ♂, with its initial weight of 75 grams, was placed on basal ration alone from December 22, 1923, until January 19, 1924, when its weight had decreased to 67 grams and the animal was very weak. Then 1 gram uray was given until February 9, 1924, when the weight had further decreased to 56 grams and the weakness had increased. Then tikitiki was substituted for uray until April 5, 1924, when the weight had increased to 124 grams. The tikitiki supply was then cut off until May 6, 1924, when the animal weighed 86 grams. At this time the animal appeared very weak and it was feared that it would die; so tikitiki was again given until the animal weighed 118 grams. Then basal ration alone was given until the animal had decreased to 92 grams. Then yeast was administered until the rat weighed 195 grams. Then again 1 gram uray was given in place of yeast until September 13, 1924, when the weight had decreased to 125 grams. From this time 1 gram camote was given until November 11, 1924, when a weight of 224 grams had been attained. Camote was again cut off, and eleven days later the weight was 192 grams. Uray extract equivalent to 2 grams dry weight was administered until December 13, 1924, when the weight had decreased to 137 grams and weakness was observed. Then camote was given in place of the extract until January 20, 1925, when the weight was 247 grams and full recovery was observed.

ILLUSTRATIONS

TEXT FIGURES

FILICES ALIQUOT NOVAE ORIENTALES

By Edwin Bingham Copeland

Of Chico, California

ONE PLATE

Cyathea Ramosii Copel. sp. nov.

Trunco 4 cm crasso, verisimiliter breve; stipite ca. 25 cm alto, deorsum ad lineas ventrali-laterales paleis stramineo-fuscis apices versus minutissime nigro-ciliatis 10–18 mm longis lanceolatis ornato alibi nudo, minute asperulo, rhachibusque fusco-atropurpureis; frondo ca. 1 m longa, fere 50 cm lata, praecipue deorsum valde attenuata, rhachi in furca ventrale sparse velutina, alibi pilis fulvis deciduis sparse vestita; pinnis infimis remotis sensim reductis usque vix 6 cm longis pinnatifidis, medialibus 25 cm longis, 7 cm latis, subhorizontalibus, haud proximis, sessilibus, acuminatis; pinnulis multis sed non contiguis, horizontalibus, sessilibus, vix 1 cm latis, obtusis vel subacutis, $\frac{1}{2}$ ad costam pinnatifidis, costa atropurpurea inferne pilis pallidis sparsis et paleis parvis lanceolatis raris fulvis vestita; segmentis 2 mm latis, oblique truncatis, fere integris, papyraceo-chartaceis, inferne viridibus, superne paullo obscurioribus; venulis utroque latere ca. 4, fere omnibus simplicibus; soris medialibus, fuscis, nudis.

LEYTE, Dagami, *Ramos Bur. Sci. No. 15271,* August, 1912.

This is on one hand unmistakably nearly related to *C. trichophora,* of Laguna Province, Luzon, from which it differs in its much darker color, rather less ample fronds and entire segments. On the other hand, it shows obvious affinity to the group of *C. glabra.*

Cyathea Zamboangana Copel. sp. nov.

Sp. C. suluensi Baker similis et quondam cum ista confusa; trunco 3–6 m alto, 5 cm crasso, nigro, nudo, aspero, cicatricibus ellipticis 5 cm longis 2.5 cm latis ornato, capite cum stipitibus 30 cm longis spinosis tomento griseo-fulvo dense vestitis; fronde ampla, ovata, abrupte acuminata, rhachi castanea, fulvo-furfuracea, sursum glabrescente et inermo; pinnis infimis 25 cm, sequentibus 40 cm longis, horizontalibus, stipitulatis, abrupte acu-

minatis, rhachibus paleis variis, cinereo-fulvis, plus minus ciliatis vestitis; pinnulis horizontalibus vel sursum patentibus, maximis 10 cm longis, 2 cm latis, elliptico-linearibus, acuminatis, basi plerisque obliquis et subcordatis, basin versus fere ad costam pinnatis; segmentis 5 mm latis, oblique truncato-cuspidatis, apices versus integris vel obscure denticulatis, alibi integris, papyraceo-chartaceis, inferne paullo pallidioribus; costa inferne cum paleis parvis cinereis sparsis polymorphis plerisque laciniatis, costulis squamulis cinereis plerisque bullatis valde apiculatis interdum ciliatis ornatis; venis utroque latere ca. 6, plerisque furcatis; soris medialibus, indusio fusco, persistente.

MINDANAO, mountains back of San Ramon, Zamboanga, alt. 500 meters, *Copeland No. 1646,* February, 1905.

This was identified as *Cyathea suluensis* Baker, and specimens were distributed under that name; but examination of a fragment of the type of that species shows that the pinnules are broadest at the base instead of above it; the segments dentate near the apex, but not drawn to a sharp point; the costa clothed only with a sparse and minute scurf; and the veins (costules) with brown, strongly bullate, but not long-pointed scales.

Dennstaedtia Shawii Copel. sp. nov.

Stipite alto rhachique glabris, inermibus, castaneis, vix nitidis; fronde 45 cm alta, oblonga; pinnis pluriparibus, inferioribus aequalibus, oppositis, fere sessilibus, 15–20 cm longis, 6 cm latis, acuminatis, infimis ad basin abrupte angustatis; pinnulis$^{\mathrm{I}}$ subsessilibus, deltoideo-lanceolatis, acutis vel subacuminatis, 12–15 mm latis, pinnulis$^{\mathrm{II}}$ oblique trapeziformibus, breviter alato-stipitulatis, maximis 6–8 mm longis, 5–7 mm latis, incisis, glabris, subcoriaceis; soris parvis, in sinubus.

PAPUA, mountains behind Taupota, leg. Rev. P. C. Shaw, *King No. 491.*

Like *D. cuneata* in the small, broad ultimate pinnules, and intermediate in character between this group and that of *D. ampla,* suggesting the latter group by its naked, dark, somewhat shiny axes and the texture and brownish green color of the foliage.

Humata parvula (Wall.) Mett.

PAPUA, mountains behind Taupota, leg. Rev. P. C. Shaw, *King No. 495.*

In Malaya, but apparently new to New Guinea.

Davallia Robinsonii Copel. sp. nov.

D. solidae affinis, textura tenuiore et soris longioribus plerisque solitariis distinguenda; rhizomate 6 mm crasso, lignoso,

glauco, paleis nigris fusco-marginatis lineari-lanceolatis apices versus ciliatis persistentibus dense obtecto; stipite 15–20 cm alto, fulvo-fusco, frondeque glabris; fronde ca. 30 cm alta, late deltoidea quadripinnatifida; pinnulis ultimis subcoriaceis, inferioribus ovatis acutis, superioribus lanceolatis acuminatis, basi cuneatis integris, alibi valde incisis, venis spuriis carentibus; soris inferioribus medio ad baseos interfissis, superioribus pluris omnino separatis et ad dentes angustos solitariis, 2 mm longis, 0.6 latis utrinque anguste alatis; indusio apice truncato, cum lamina conterminante.

MINDANAO, prope Cotabato, ad arbores, leg. C. B. Robinson, *Bur. Sci. No. 11704.*

This approaches *D. mauritiana* Hook. in appearance. *Davallia solida* has quite uniformly longer sori in Mindanao than elsewhere, thus approaching the extreme represented by the species just described.

Saccoloma caudatum Copel. sp. nov.

Rhizomate, teste King, longo, crasso, nigro; fronde grande, glabra, laete viride, herbacea, quinquepinnatifida, rhachi straminea; pinna unica visa ultra 40 cm longa, 20 cm lata, obliqua; pinnulis^{I} inferioribus 5 cm latis, in caudas inciso-serratas usque ad 4 cm longas extensis, stipitulatis, basi obliquis; pinnulis^{II} deltoideo-lanceolatis, infimis acuminatis, aliis acutis, majoribus ad alas angustas pinnatis; pinnulis^{III} infimis acroscopicis ultra 1 cm longis, 3-4 mm latis, profunde pinnatisectis, acutis, basi obliquis, segmentis majoribus cuneatis; soro in segmento quoque uno, in segmentis maximis laterale, in aliis plerumque infra-apicale, subimmerso, indusio cuneato, margine libero rotundato vel crenato, apicem segmenti interdum superante.

PAPUA, Hydrographers Range, alt. 900 meters, *King No. 462.*

Rather like a *Dennstaedtia* in appearance, but with the indusium of *S. moluccanum,* from which it differs in being larger, more cut, and thinner, aside from the remarkably caudate pinnules. The inclusion of these two species in *Saccoloma* might be criticized.

Pteris Warburgii Christ (*Pt. Finisterrae* Rosenstock).

PAPUA, watershed overlooking Mullin's Harbour, alt. 3,000 to 4,000 feet, *King No. 474.*

This specimen is unlike the descriptions in being merely pinnatifid, with the lowest segments connected with the following by a broad wing, as well as adnate on the lower side, indicating perhaps that it is a juvenile or underdeveloped individual. More

ample collections will eventually show whether or not the merely pinnatifid plant is distinct. Except in venation, the sterile frond resembles *Blechnum Patersoni* to a surprising extent. The fertile frond is much contracted. The fertile margin is very "deep," at a right angle to the plane of the frond, as in *Schizostege.* The rhizome is very stout, and suberect. The identification of *Pt. Finisterrae* with *Pt. Warburgii* is on the authority of Rosenstock.

Tectaria minuta Copel. sp. nov.

Caudice parvo, suberecto, paleis castaneis lanceolatis attenuatis integris usque ad 3 mm longis vestito; stipitibus confertis, 2–4.5 cm altis, gracilibus, atris, baseos versus sparse paleatis, alibi minute velutinis, sursum costisque glabrescentibus; frondibus simplicibus, ovatis, cordatis, apice rotundatis, late crenatis vel maximis sublobato-crenatis, papyraceis, glabris, inferne pallidis, 3–4 cm longis, 23–27 mm latis; venis vix conspicuis nec ad marginem attingentibus, venulis reticulationem laxam cum liberis paucis inclusis efficientibus; soris sparsis; indusio rotundato-reniforme, persistente.

PAPUA, mountains behind Taupota, leg. Rev. P. C. Shaw, *King No. 493.*

As is usually true of such dwarfs, it may be suspected that this fern may reach a greater size, and then differ considerably in appearance. However, the specimens sent are quite uniform and bear numerous fruiting fronds.

Tectaria (Arcypteris) diversisora Copel. sp. nov.

Caudice erecto, 1 cm crasso, apice paleis minutis vestito; stipitibus confertis, 35–40 cm altis, atropurpureis vel deorsum nigrescentibus, nitidis, deorsum paleis paucis angustis deciduis castaneis ornatis, aliter glabris; fronde normale profunde tripartita, 14–20 cm longa, 10–17 cm lata, late cordata, subcoriacea, glabra, inferne pallida; segmentis acuminatis, mediale majore oblongo-lanceolato, 4–7 cm lato, integro, lateralibus obliquis; costis validis, atrocastaneus; venis primariis remotis, fere ad marginem protensis, venulis obscuris; soris irregularibus, plerisque oblongis, linearibus et orbicularibus interspersis, nudis.

PAPUA, Hydrographers Range, *King No. 470.*

The fertile fronds are somewhat narrower and longer-stalked than the sterile. Considering the texture, the parenchyma of dried plants is notably translucent, making the venation conspicuous by transmitted light. The parenthetic name, *Arcypteris,* is used in a purely descriptive sense; the nearer affinity of

this species is not to *T. irregularis,* but to the group of *T. platanifolia, T. Labrusca,* etc., an easily recognized and natural group, with various indusia or none at all.

Genus **TECTARIDIUM** Copel. novum

Genus ex Tectaria evolutum, frondibus biformibus, sterilibus simplicibus venatione sagenioidea, fertilibus aut pinnatis aut cum costa anguste alata, pinnis angustis late distantibus, cum lamina usque ad substratum sororum contracta; indusiis grandibus, persistentibus.

Tectaridium MacLeanii Copel. sp. nov. Plate 1.

Rhizomate erecto, 8 mm crasso, paleis linearibus rubido-castaneis dense vestito; stipitibus atropurpureis, paleis linearibus rubido-castaneis plus minus persistentibus vestitis, frondium sterilium 5–10 cm, fr. fertilium 20–35 cm altis; fronde sterile lineari-elliptica, 35–45 mm lata, 15–20 cm alta, acuta, basi cordata vel subcordata, integra, herbacea, glabra, olivacea, costa deorsum atropurpurea, sursum pallescente; venis primariis inconspicuis, fere ad marginem attingentibus, venulis reticulationem laxam efficientibus venulis inclusis simplicibus vel hamatis; fronde fertile 20–35 cm alta, caudata; pinnis utroque latere 15–35, infimis remotis paullo abbreviatis, medialibus 25–30 mm longis, horizontalibus, nunc pinnatis nunc rhachillis anguste alatis; pinnulis vel segmentis suborbicularibus, in alam rhachillae decurrentibus, lamina soro solitario obtecta, soris ad pinnam medialem quamque 5–8 paribus, plerisque oppositis; indusio orbiculare, fere 2 mm lato, cum segmento vel pinnula fere conterminante, rarius peltato, saepius lineam secus medialem de puncto centrale usque ad marginem basalem affixo, persistente.

LUZON, Laguna Province, northeast of Paete, on well-drained hillside near Pabuntoc River, alt. 260 meters, coll. by Dr. F. T. McLean, March, 1917.

Tectaridium primitivum Copel. sp. nov.

Rhizomate valido, erecto vel adscendente; stipitibus confertis, frondis sterilis 5–15 cm altis, atropurpureis nitidis, paleis squarrosis castaneis lineari-lanceolatis vestitis, frondis fertilis duplo vel triplo longioribus; fronde sterile anguste lanceolata, ca. 25 cm alta, 4.5 cm lata, acuta, basi truncata vel late cuneata, integra vel late crenata, glabra, coriacea, costa inferne carinata; venis primariis obliquis, marginem fere attingentibus, venis aliis immersis, irregularibus, anastomosantibus cum venulis furcatis inclusis multis; fronde fertile 25 cm alta 5 cm lata, usque ad

alam angustam costae pinnatifida, segmentis 1 cm distantibus vel deorsum remotioribus, horizontalibus, medialibus 2–2.5 cm longis, ca. 2 cm latis; soris utroque latere costulae uniseriatis, magnis, superficialibus, mox contiguis; indusio orbiculare-reniforme, persistente.

LEYTE, Jaro, alt. 500 meters in silva, leg. *Wenzel No. 876.*

Of these two plants, Wenzel's came first into my hands and, with misgivings, it was diagnosed as a *Tectaria,* "altogether distinct from any other known species." Before I was ready to publish this, McLean's plant was brought in, with still more complete elimination of the lamina of the fertile frond.

Tectaridium is certainly a descendant of *Tectaria,* and is therefore correctly named (on suggestion by Mr. Maxon. It may be noted that *Pteridium* is not an appropriate name, as this fern is nearer to any common ancestor than is *Pteris.*) It is unlike the other ferns with very dimorphous fronds—*Hemigramma* and various ferns commonly bunched in *Leptochilus* and *Stenosemia*—in retaining conspicuous indusia. *Tectaria decurrens* rarely has fertile simple fronds, and may represent the place of origin of *Tectaridium* in the parent genus.

Asplenium Shawii Copel. sp. nov.

Stipite ultra 20 cm alto, rhachibusque atris et glabris; fronde ca. 35 cm alta, ovata, tripinnata, membranacea, atroviride; pinnis infimis paullo reductis, sequentibus ca. 16 cm longis, 7 cm latis, acuminatis; pinnulis [i] pedicellatis, acutis, 1 cm latis basi fere aequilateralibus; pinnulis [ii] pedicellatis, late oblongis, obtusis vel truncatis, basi oblique late cuneatis, majoribus ultra mediam incisis, lobis integris vel sparse dentatis; venis in pinnula quaque plerumque pinnatis, apicibus haud incrassatis; soris brevibus, indusiis castaneis, apud insertiones nigrescentibus.

PAPUA, mountains behind Taupota, leg. Rev. P. C. Shaw, *King No. 494.*

Darker and more lax than *A. laserpitiifolium.* Distinguished within its group by the equal-sided primary pinnules, small, broad ultimate pinnules, and dark color. There is no sign of proliferation, and the texture is such that none is to be expected.

Asplenium Goadbyi Copel. et Watts sp. nov.

Rhizomate ignoto; stipite ultra 10 cm alto, atrogriseo, glabrescente; fronde 25–30 cm alta, 7–10 cm lata, lanceolata, acuta, deorsum paullo vel non angustata, rhachi paleis parvis profunde fissis castaneis vestita; pinnis ca. 16-paribus, brevipedicellatis, usque ad 7 cm longis et 2 cm latis, oblique deltoideo-lanceolatis,

acutis vel acuminatis, praecipue apices versus serratis, basi inferiore cuneata superiore truncata interdum subauriculata semper valde dilatata, chartaceis, pallidis, superne sparsiter inferne densius paleis minutis plus minus ad basin fissis castaneis vestitis; soris linearibus, usque ad 16 mm longis, ad marginem et costam fere attingentibus, basalibus longioribus curvatis, indusio pallido-marginato.

NEW BRITAIN, Herbartshoe, leg. *Lt. Goadby No. 1.* The associate author is the Rev. W. W. Watts.

This has the general appearance of a member of the group of *A. falcatum,* but the pubescence is very different. The paleæ are one- to five-branched, rarely still more dissected, with or without some paler cells between the axes at the base. Similar branched hairs or scales are found on *A. pellucidum* Lam., *A. horridum* Kaulf., and, especially developed, on *A. paleaceum* R. Br.; a suggestion of the same structure is found on *A. caudatum* Forst. and *A. diversifolium* Bl.

Loxogramme spatulata Copel. sp. nov.

Rhizomate filiforme, 0.5–0.8 mm crasso, paleis 1–2.5 mm longis acuminatis basibus insigniter dilatatis ad et apud pseudopodia persistentibus, alibi caducis; frondibus remotis, usque ad 12 cm longis et 12 mm latis sed plerisque minoribus, 1–1.5 cm infra apicem latissimis, cuspidato-acuminatis, lamina deorsum ad alam angustam usque ad articulationem inconspicuam protensam angustata, margine angustissime cartilaginea, costa superne praestantiore, infra apicem immersa; soris immersis, ad partem dilatatam frondis restrictis, obliquis, utroque latera 4–7, tum demum confluentibus.

CHINA, Hupeh, S. Wushan, on rocks, *E. H. Wilson No. 620.* Type in the Hongkong Herbarium.

A species of the group of *L. malayana,* notable for its small size and the extreme development of the tendency, shown by the fronds of almost the whole genus, to become broader above the middle.

ILLUSTRATION

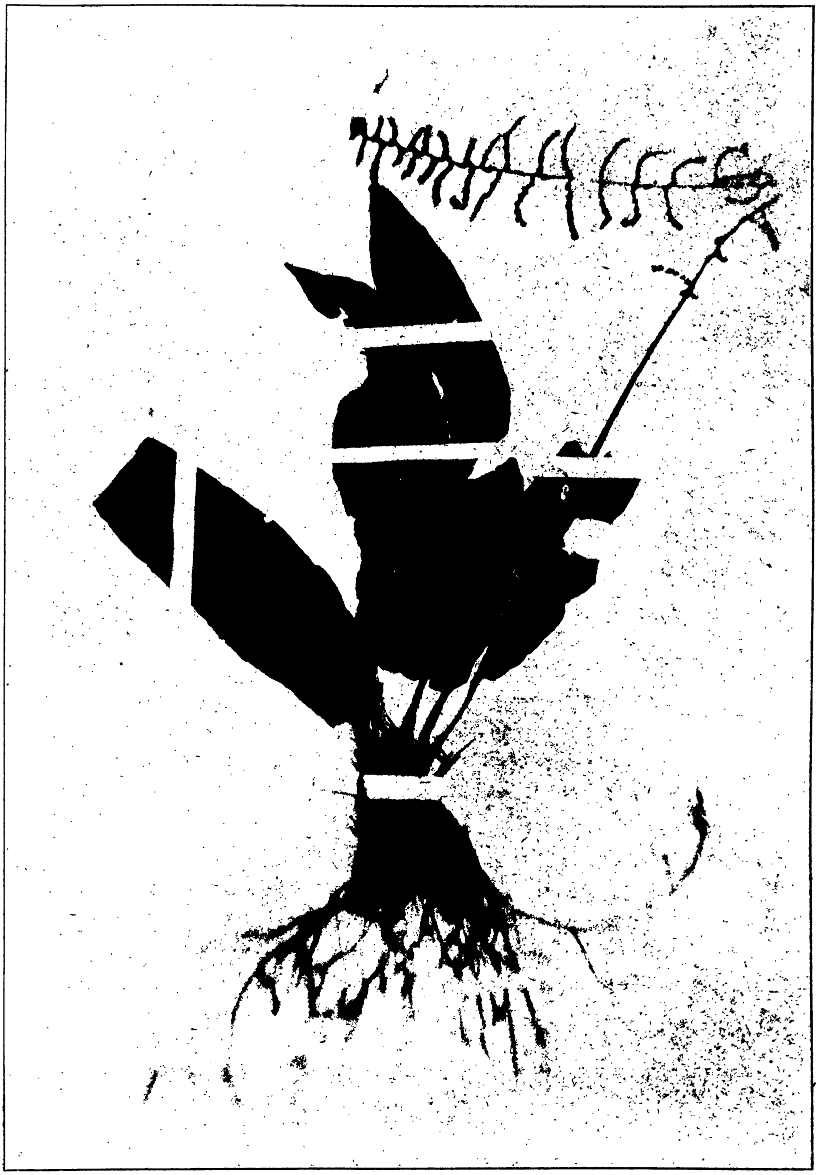


PLATE 1. TECTARIDIUM MACLEANII G. AND SP. NOV.

NOTES ON HEALTHY CARRIERS OF DYSENTERY BACILLI

By Kozo Saisawa

Major General, Army Medical School, Tokyo, Japan

and

Bunshiro Tanabe

Lieutenant Colonel, Army Medical School, Tokyo, Japan

During an epidemic of bacillary dysentery healthy dysentery carriers are frequently found in rather great numbers among persons who come in contact with dysentery patients. Our experience in that respect confirms the findings of many authors, as reported in the literature. There are few reports on dysentery carriers among healthy persons during the period when bacillary dysentery is not prevalent. While we were investigating carriers of pathogenic intestinal bacilli a few years ago, we had opportunity to find so-called healthy carriers of dysentery bacilli during a time when bacillary dysentery was not prevalent. Thus we obtained some results which are described in this paper.

THE PROCEDURE OF INVESTIGATION, THE SOURCE OF MATERIAL, AND THE NUMBER OF CARRIERS FOUND

As soon as a large number of recruits entered the Imperial Guards Regiments (infantry and cavalry) in Tokyo in January, 1924, they were subjected to a bacteriological examination for the purpose of determining whether or not they were bacillus carriers. Their stools were sent to our laboratory, and the routine stool examination was made twice on each individual. Two thousand eight hundred forty-seven men were examined. From these we isolated dysentery bacilli in fifteen (0.52 per cent). As to the type of dysentery bacillus, we found "Y" (Hiss-Russell) type in eight cases, Flexner in six, and nonfermenter of mannite in only one case. These men, in both infantry and cavalry regiments, were recruited from various parts of Japan where bacillary dysentery was not prevalent at that time.

In addition to these dysentery carriers one case of typhoid carrier and one case of paratyphoid A carrier were detected.

Furthermore, four thousand six hundred forty-eight trained soldiers belonging to various units of our Imperial Guards Division were examined for the purpose of determining whether or not they were bacillus carriers in the period from March to December, 1924. During this time some cases of bacillary dysentery occurred sporadically. Fifteen men (0.32 per cent) among the four thousand six hundred forty-eight were discovered as harboring dysentery bacilli. From these fifteen cases we isolated "Y" (Hiss-Russell) bacillus in nine cases, Flexner in four, mannite nonfermenter in one, and Shiga bacillus in only one case. As a general rule, the stool examination was made twice. Some soldiers, however, were examined only once on account of their special condition of service. Others were examined more than twice.

Furthermore, we examined bacteriologically five hundred ninety-eight men who belonged to the Reserve Corps and were reënlisted for the training service for a short time in April and May, 1924. Only one case among these five hundred ninety-eight was noted as excreting dysentery bacillus ("Y" type). In January, 1925, one thousand four hundred sixty-five men of the First Regiment of the First Division in Tokyo were examined once for pathogenic intestinal bacilli. Of these, four were found to harbor dysentery bacillus. From these four carriers we isolated Flexner bacillus in three cases and "Y" in one. In these cases the stool examination was made only once. According to this investigation, even at the time when bacillary dysentery was not prevalent there were found about 0.52 per cent of army recruits (all young men about 20 years old) who excreted dysentery bacilli. About 0.32 per cent of trained soldiers living in the barracks were also harboring the pathogenic germ of dysentery. These bacillus carriers were all in perfectly good health and gave no history of ever having had dysentery, so far as could be ascertained. Moreover, the appearance of the stools was noted as normal. None of them had had dysentery during the period when they were isolated.

TYPES OF DYSENTERY BACILLI ISOLATED FROM HEALTHY CARRIERS

Thirty-one strains were isolated from the bacillus carriers. These strains were carefully and thoroughly identified. The majority of them belonged to the acid types; that is, the "Y"

(Hiss-Russell) and the Flexner types. The typical Shiga bacillus was found in only one case.

The classification of the types of *B. dysenteriæ* was, therefore, as follows:

Type.	Cases.
"Y", (Hiss-Russell)	18
Flexner	10
Shiga	1
Nonfermenter of mannite	2
Total	31

The strains of nonfermenters of mannite belonged to a type which ferments maltose and dextrin but does not affect mannite. Recently I. Tanaka studied these strains under the direction of one of us (Saisawa) and published the results of his work in the Scientific Reports from the Government Institute for Infectious Diseases, Tokyo, 1925. Both morphologically and biologically all of the isolated strains were identified, and they corresponded to the standard types. Some strains of "Y" and Flexner type were used for animal experiments soon after isolation from the carriers. They were all pathogenic for mice and guinea pigs and showed a fairly high degree of virulence. Blood specimens were taken from some of the carriers for immunological tests. The sera of the carriers agglutinated the strains isolated from them as well as the corresponding laboratory strains, the titer varying from 1 : 40 to 1 : 160.

DURATION OF THE STATE OF DYSENTERY CARRIER AND THE NUMBERS OF DYSENTERY BACILLI EXCRETED IN THE STOOLS OF HEALTHY CARRIERS

Eighteen bacillus carriers were selected, to enable us to observe for how long and in how large numbers the pathogenic microörganism was discharged in their fæces. The stools of the carriers were examined two or three times a week by the customary bacteriological methods. The sigmoidoscopic method was also applied for ascertaining the condition of the rectum and sigmoid whenever possible. This method enabled us to secure specimens directly from the inflamed area itself and will be described later on. Our observation continued as long as the carrier state persisted. Table 1 shows the results. As will be seen from Table 1 the majority of the carriers continued to excrete the pathogenic microörganism in question in their stools for a long time after it was first detected by us as such. The

TABLE 1.—*Showing the duration of the carrier state in bacillary dysentery.*

[+, positive culture; —, negative culture; R, recto-sigmoidoscopic examination.]

No.	Name of healthy dysentery carrier.	Type of dysentery bacillus.	Date of first examination.	1st week.	2d week.	3d week.	4th week.	5th week.	6th week.	7th week.	8th week.
			1924								
1	U. Aisawa	Y	Mar. 11, +	—+	—++	+++	++	—+	R ——+	——	——
2	T. Ota	Y	Mar. 16, +	———	+——	+——	+——	R +++	+—	+—	——
3	E. Kuroda	Y	Apr. 14, +	+++	R +++	++—	—++	———	+——	+++	————
4	K. Sekiguchi	Y	Mar. 14, +	—	—+——	——+	+——	—	————	+—	R —+—
5	S. Shinohara	Y	Apr. 1, +	—+	——	————	——+	R —+—	——	——	——
6	N. Saito	Y	Apr. 11, +	———	++—	+—	R ——	—+	———	———	—+—
7	M. Fukuda	Y	Apr. 9, +	+——	+	++	R ——+	———	———	——	——
8	I. Yoshida	Y	May 9, +	———	R +——	—+	———	———	———	—	
9	T. Fukuda	Y	May 23, +	R +—	———	———	———	—			
10	E. Sugaya	Y	May 25, +	R +—+	+——	———	———	——			
11	T. Miyao	Y	Apr. 9, +	+—	————	——	———	—+—	———	R ———	——
12	M. Miyaji	Nonfermenter of mannite.	June 6, +	R +——	———	———	—				
13	Y. Ida	Y	Oct. 13, +	——+	—	R ——	——+	———	———	———	—
			1925								
14	S. Yahagi	Flexner	Jan. 26, +	+——	—	——	R R +++—	—	———	———+	———

15	T. Enomoto	do.	Feb. 26, +	+—	R R +——+	———	+——	——	———	—	——
16	S. Ito	do.	Jan. 22, +	—	———	—+	R +++	+++—	R +—	———	+———
17	K. Hasunuma	do.	Feb. 24, +	———	R ———	———	———	—			
18	K. Omori	Y	Feb. 25, +	R +—	—	R ———————	———	—			

No.	Name of healthy dysentery carrier.	Type of dysentery bacillus.	Date of first examination.	9th week.	10th week.	11th week.	12th week.	13th week.	14th week.	15th week.	16th week.	17th week.
			1924									
1	U. Aisawa	Y	Mar. 11, +	———	————	———						
2	T. Ota	Y	Mar. 16, +	———	—+	———	———	——+	———	—	—	——
3	E. Kuroda	Y	Apr. 14, +	———	——	—						
4	K. Sekiguchi	Y	Mar. 14, +	——+	————	—++	———	———	———	—		
5	S. Shinohara	Y	Apr. 1, +	———								
6	N. Saito	Y	Apr. 11, +	———	——							
7	M. Fukuda	Y	Apr. 9, +									
8	I. Yoshida	Y	May 9, +									
9	T. Fukuda	Y	May 23, +									
10	E. Sugaya	Y	May 25, +									
11	T. Miyao	Y	Apr. 9, +	—								
12	M. Miyaji	Nonfermenter of mannite.	June 6, +									
13	Y. Ida	Y	Oct. 13, +									
			1925									
14	S. Yahagi	Flexner	Jan. 26, +	————	————	—	—					
15	T. Enomoto	do.	Feb. 26, +									
16	S. Ito	do.	Jan. 22, +	———	——	———	——	——				
17	K. Hasunuma	do.	Feb. 24, +									
18	K. Omori	Y	Feb. 25, +									

longest period of duration of the carrier state was thirteen weeks. A review of Table 1 shows the length of time during which *B. dysenteriæ* was found in the stools of our carriers.

Carriers.	Stool cultures became negative within—
4	1 week.
1	2 weeks.
6	3 to 5 weeks.
7	6 to 13 weeks.
Total 18	

The excretion of the bacilli was very irregular and intermittent. Continual excretion was seldom observed. In the majority of cases periods of positive cultures were followed by periods of negative cultures for a varying length of time. In some instances, after repeated stool examinations had been negative for as long as four weeks, the persistent examinations suddenly gave positive findings. From four to eight routine examinations were made during this time, as can be seen from Table 1 (Nos. 2, 4, 6, and 13). Carrier 11 suddenly showed a positive dysentery culture after negative cultures had been obtained eleven times. In the beginning the negative or free periods were relatively short. They gradually became longer and longer until the pathogenic bacillus could no longer be recovered from the stools.

The respective dysentery bacilli were present in varying amount. Most of the carriers excreted them in small numbers. In some cases, however, dysentery bacilli were found in enormous numbers, and sometimes in almost pure culture.

It has been hitherto believed that healthy dysentery carriers excrete a pathogenic microörganism for a brief period of time, and that they may be temporary carriers of short duration. We have had similar experience when the bacteriological examinations were made on contact carriers during an epidemic of bacillary dysentery. At that time the stool examinations were made by the usual methods and were repeated on three or four successive days only. The sigmoidoscopic method was not applied for this purpose at that time. Our recent investigation, however, as already stated, showed that some of the so-called healthy dysentery carriers harbored the pathogenic bacillus for a fairly long time. They were not temporary carriers, but rather chronic ones.

THE SIGMOIDOSCOPIC METHOD AND ITS APPLICATION TO THE BACTERIOLOGICAL EXAMINATION

Many authors have already shown that the application of the sigmoidoscope is an especially useful method in chronic cases of dysentery, and that it should be applied for the purpose of diagnosis and treatment as well. So far as we know, nobody has employed this useful apparatus for the examination of healthy bacillus carriers.

The sigmoidoscope used by us was that devised by H. Strauss. The mucous membrane of the rectum and sigmoid was carefully examined. If any lesion was found, specimens were taken from the lesion itself and examined for dysentery bacillus. The results thus obtained will now be described.

On the evening previous to examination for carriers a small dose of aperient saline was given to the soldiers. The next morning a plain water enema (0.5 to 1 liter) was given one or two hours previous to the examination proper. The instruments that come in contact with the lesion should be sterilized by boiling, and the application of any chemical disinfectants which might kill the dysentery bacilli should be avoided.

CLINICAL FINDINGS IN HEALTHY DYSENTERY CARRIERS SECURED BY THE SIGMOIDOSCOPE

As Table 2 shows, certain lesions were observed on the mucous membrane of the rectum and sigmoid flexure in a majority of the carriers. In some cases there was noted a very small lesion, or in a few cases the mucous membrane had an entirely normal appearance, so far as the sigmoidoscope showed. The principal lesions observed consisted of ulceration, formation of pseudomembrane, inflammation of solitary follicles, and production. of mucus and granulation tissue.

Ulceration of the mucous membrane was one of the most important findings. It was noted in nine cases out of the eighteen. In most of the cases one or several ulcers were found on the back wall of the lower part of the sigmoid flexure, about 12 to 15 centimeters deep from the anus. The location of the ulcers varied somewhat. In some cases they were observed at the entrance of the sigmoid or in the ampulla. They were superficial, round ulcers with irregular edges, lenticular in shape, about 0.5 to 1 centimeter in diameter. The edge was prominent and undermined in some instances. The ulcers were

TABLE 2.—*Showing the lesions in the rectum and sigmoid flexure observed by the aid of the sigmoidoscope, their topography, and the results by cultures made from the inflamed area itself.*

[—, negative; +, few colonies; + +, fairly numerous colonies; + + +, numerous colonies.]

No.	Name of healthy dysentery carrier.	Date of examination.	Lesions in rectum and sigmoid flexure.				Cultures from—	
			Ulcers.			Other lesions, distance from anus.	Ulcers.	Mucus, pseudomembrane.
			Distance from anus.	Number.	Outline, shape (size).			
		1924	*cm.*					
1	U. Aisawa	Apr. 21	13–14	2	Elliptical (1 cm in diameter) irregular, rounded, ca. 1 cm in diameter.	Area around the ulcers and the rectal canal downward showed catarrhal inflammation.	+	
2	T. Ota	Apr. 26	13.5		Rounded oval, size of a pea		++++[a]	
3	E. Kuroda	Apr. 26	9		do	Scar at 14 cm. The surrounding intestinal canal was a little constricted.	+	
4	K. Sekiguchi	May 7				A large quantity of mucus at 25 cm		+
5	S. Shinohara	May 7	8 14.5	1 2	Rounded oval, size of a pea, lenticular ca. 0.5 cm in diameter.	A large pseudomembrane formed at 10 cm	++	+++
6	N. Saito	May 7				Scar at 16 cm, two scars at 20 cm	—	
7	M. Fukuda	May 10				Many small scars at 7 to 11 cm	—	
8	I. Yoshida	May 21	7	1	Rounded oval, size of a pea	A large pseudomembrane formed at 9 to 11 cm.	+	+
9	T. Fukuda	May 30				Mucosa was generally inflamed without any ulceration.		—
10	E. Sugaya	May 30	14–15	4	Very small		—	
11	T. Miyao	May 30				Scar at 6 cm, a large pseudomembrane at 5 to 7 cm.		—
12	M. Miyaji	June 10	12	1	Rounded oval, size of a pea	Intestinal canal was bent at 14 cm. The upper part could not be reached.	+++	
13	Y. Ida	Nov. 8				A scar at 17 cm	—	

		1925						
14	S. Yahagi	Feb. 20	13	1	Rounded oval, size of a pea	A large quantity of mucus	+	+
		Feb. 23	18	1	do.	A large quantity of mucus. Ulcers bled easily.	+	+
		Mar. 14	18			Ulcer at 13 cm was no longer found	+	++
15	T. Enomoto	Mar. 3	12	1	Elliptical, ca. 0.5 cm in long diameter.		+	
					Erosion		+	
16	S. Ito	Feb. 20				Mucus at 5 to 25 cm	+	+
		Mar. 3				Pseudomembrane formed at 25 cm, which was stripped off with difficulty. It bled easily from the mucous membrane. Mucus at 5 to 16 cm. (Sigmoiditis follicularis).	+	+
		Mar. 14				Thick mucus obscured the view at 12 to 19 cm.		
		Mar. 23				It was wiped off and then lymphatic follicles were seen. They were swollen and hypertrophied, with hyperæmic or easily bleeding point at their center (Sigmoiditis follicularis), mucous membrane having a velvety appearance.		—
17	K. Hasunuma	Mar. 3	14	1	Rounded, 0.5 cm in diameter	Ulcers bled easily	—	
		Mar. 14	16	1	Rounded oval, size of a pea		—	
18	K. Omori	Mar. 3				A large quantity of mucus obscured the view.		+
		Mar. 14						—

[a] In pure culture.

sometimes obscured, being covered by mucus or pseudomembrane which could be wiped off with some difficulty. In other instances the pseudomembrane consisted of a large rag, which was easily stripped off.

At the same time, catarrhal inflammation of the intestinal wall was observed around the ulceration. The mucous membrane of the inflamed area was hyperæmic and swollen, in appearance very much like velvet. The solitary lymphatic follicles of the intestine were often swollen and hypertrophic to some extent. Each inflamed follicle had a minute hyperæmic or easily bleeding point at its center. A large mass of mucus was occasionally found here and there. It was rather common to find evidence of inflammation in a scarred fibrous intestine. The granulation tissue with surrounding hyperæmia had a characteristic appearance.

In some instances no ulceration was noted anywhere, but the anal canal was full of a greenish gray mass of mucus.

BACTERIOLOGICAL EXAMINATION OF LESIONS DISCLOSED BY THE SIGMOIDOSCOPE

If an inflamed area, a patch of ulceration, a pseudomembrane, or mucus was observed with the aid of the sigmoidoscope, cultures were taken from these lesions. The area was swabbed by means of a sterile cotton plug which was moistened a little with peptone water. The material thus taken was at once spread out upon the surface of Endo plates. The results of the culture examinations are shown in Table 2.

When material was taken directly from the ulcers it was not uncommon to secure almost pure cultures of dysentery bacillus, though the colonies were few in number. *Bacillus coli* and other saprophytic nonpathogenic germs met with in the stool culture were found in very small numbers. Rarely we met with numerous colonies of dysentery bacilli. In spite of the fact that some cultures were taken directly from the ulcer, the incubated Endo plates yielded no colony of dysentery bacillus. This happened in the case of carriers 10 and 17 (Table 2). From the scarred area dysentery bacillus was never isolated. The pseudomembrane and the mucus usually contained the germ in varying numbers. When, after careful examination of the mucous membrane of the intestinal wall, from the anal canal up to the sigmoid flexure, a lesion was not noted, cultures were taken from the mucus found in the upper part of the sigmoid, especially near the vertex flexuræ sigmoideæ. Thus we obtained

a positive culture in some instances. In such a case we could assume that the lesions lay farther up in the large intestine and could not be reached by the sigmoidoscope.

There was no difficulty in taking cultures from the inflamed area itself by the aid of the sigmoidoscope. In some cases positive cultures were obtained directly from the lesion, when stool cultures, made on the same day or just before the sigmoidoscopic examination, were negative. This sigmoidoscopic method seems to have given more regular results than the mere stool method.

Notwithstanding the fact that cultures were secured from an apparent ulcer it occasionally happened that they were negative.

A review of our investigations already mentioned brings out the fact that so-called healthy carriers of dysentery bacilli giving no history of the disease actually present the same condition as do chronic or convalescent carriers. They are nothing but chronic cases of bacillary dysentery with slight pathological manifestations, such as minute ulcers and catarrhal inflammation of the mucous membrane of the large intestine in the majority of cases. This means ambulatory cases so mild that they were not even clinically suspected, though the pathogenic germ persisted for weeks in the stools in small or in large numbers, and was being excreted at varying intervals of time.

According to our investigations concerning the carrier state we estimate that one in every two hundred recruits from the general population is a dysentery carrier. This condition constitutes a great menace to the public, especially in the summer time. These bacillus carriers may be the chief factor in the spread and persistence of bacillary dysentery. The fact that healthy dysentery carriers have been found to exist during the off season is very important, from the viewpoint of epidemiology and preventive medicine. It is, furthermore, a direct demonstration of the pathologic condition which is responsible for the carrier state in bacillary dysentery.

SUMMARY

1. Recruits entering the military service in Japan and trained soldiers belonging to the Reserve Corps were examined for the purpose of finding bacillus carriers, as soon as they entered the army in Tokyo. Among the two thousand eight hundred forty-seven recruits of the Japanese Imperial Guards Regiments (infantry and cavalry) we found fifteen healthy dysentery carriers (0.52 per cent). Healthy carriers of dysentery bacillus were also found among enlisted men who were living in the

barracks in Tokyo and who were all in perfect health. Fifteen men (0.32 per cent) out of four thousand six hundred forty-eight examined were found to harbor the dysentery bacillus. The carrier rate among recruits entering the barracks was a little higher than among soldiers who were living in the barracks. Both groups, however, showed the almost general presence of dysentery carriers.

2. As to the types of dysentery bacillus, from the total of thirty carriers we isolated "Y" (Hiss-Russell) type in seventeen cases, Flexner in ten, nonfermenter of mannite in two, and the typical Shiga bacillus in only one case.

3. The excretion of the pathogenic germ was very irregular. Continuous excretion was rarely observed. On the contrary, in a majority of cases periods of positive cultures for a longer or shorter time were followed by periods of negative cultures for a varying length of time. In some instances the negative periods were as long as four weeks.

4. In most of the cases the carrier state persisted for a considerable time, including a certain lesion in the intestinal canal on one hand and the elimination of the germ in the stools on the other. Some of the carriers passed dysentery bacillus in their stools for as long as thirteen weeks after their detection as dysentery carriers.

5. We applied the sigmoidoscope to the examination of dysentery carriers. By the aid of this apparatus we observed, in most of the cases, ulceration or some other sign of inflammation on the mucous membrane of the lower part of the sigmoid flexure and of the rectal ampulla.

6. In cultures made from the ulcers, mucus, or pseudomembrane we secured colonies of dysentery bacillus in greater or lesser numbers. In some instances they grew in almost pure cultures and without difficulty. The sigmoidoscopic method enabled us to obtain more regular results than did the stool cultures.

7. We believe that the great majority of so-called healthy or contact dysentery carriers are nothing but very mild cases of dysentery with such slight pathological and clinical manifestations that an infection by *Bacillus dysenteriæ* is not suspected.

NOMENCLATORIAL NOTES ON THE JASSOIDEA, V

By C. F. BAKER
Dean, College of Agriculture, Los Baños

Jassus dubiosus nom. nov. for *Jassus dubius* Osborn, 1924, not *Jassus dubius* Walker, 1851.

Thamnotettix reiteratus nom. nov. for *Thamnotettix chapadensis* Osborn, 1924, not *Thamnotettix chapadensis* Baker, 1923.

Thamnotettix luteosus nom. nov. for *Thamnotettix luteus* Osborn, 1924, not *Thamnotettix luteus* (C. Sahlberg), 1871.

TWO CORRECTIONS IN NOTES ON THE JASSOIDEA, IV

The name *Erythroneura lawsoni*, proposed by me[1] for a species in the Jassoidea, is preoccupied; I therefore propose the name **Erythroneura lawsoniana** nom. nov. instead.

Also, in the same paper, the authority for *Athysanus coronatus* should be Berg, not Bergroth.

[1] Philip. Journ. Sci. 27 (1925) 537.

.NEW CURCULIONIDÆ FROM THE MALAY ARCHIPELAGO (COLEOPTERA)

By Guy A. K. Marshall
Head, British Imperial Bureau of Entomology
London, England

Among some Curculionidæ, principally from Sandakan, British North Borneo, kindly submitted to me by Prof. C. F. Baker, there occurred several new species, which are described in the following pages.

The type specimens of all the species will be deposited in the British Museum.

OTIORHYNCHINÆ

Epicalus sandakanus sp. nov.

Male and female.—Integument piceous, clothed with dense sandy brown scaling, which is rather paler beneath, and set dorsally with short erect spatulate setæ.

Head with the coarsely facetted eyes subdorsal and not prominent, their convexity exceeding but little that of the head; the forehead almost flat transversely, its width equal to the length of an eye, and with a row of four or five suberect spatulate setæ on each side; the sculpture entirely concealed by the scaling. Rostrum somewhat broader than long, parallel-sided in the basal half and very slightly wider in front; the median dorsal area of about one-third the total width, gradually narrowing from the base to the antennæ, then dilated and deeply impressed at the apex, the anterior margin being a posteriorly concave high transverse carina, which unites the apices of the scrobes and forms the basal margin of the almost vertical epistome, the anterior edge of which is not emarginate; the scrobes short and broad, curving inward behind; the mentum with three setæ on each side. Antennæ with the scape curved in the basal third, thence straight, very gradually widening at the apex, densely squamose and with erect spatulate setæ; the funicle with joint 2 very slightly longer than 1, the remainder subequal, squamose and with spatulate setæ, except joint 7 which has fine setæ and no scales. Prothorax very slightly broader than long,

gently rounded at the sides, widest in the middle, shallowly constricted near the apex, which is not narrower than the base, the latter being bisinuate; the dorsum almost flat longitudinally, rugosely punctate, with a shallow curved transverse impression at one-third from the apex and a shallow rounded depression on each side behind the middle, but the sculpture almost entirely hidden by the dense scaling. Scutellum very small, squamose. Elytra ovate, separately rounded at the base, much wider than the prothorax at the rounded subrectangular shoulders, gently rounded at the sides and widest well behind the middle; the striæ with their shallow punctures entirely hidden by the scaling; the intervals broad, gently convex, and densely squamose, each bearing an irregular row of short erect spatulate setæ, and interval 1 not elevated posteriorly. Legs densely squamose; the femoral tooth situated at about the middle of the femur; the intermediate tibiæ strongly curved.

Length, 2.7 to 3 millimeters; breadth, 1.2 to 1.3.

BORNEO, Sandakan (*C. F. Baker*).

The genotype, *E. virgatus* Motschulsky (1858), differs in having the sides and lower surface of the body clothed with metallic green scales; the rostrum is much narrower, and the forehead relatively broader; intervals 1, 3, and 5 on the elytra are more raised than the others, and the setæ are minute and recumbent.

EREMNINÆ

Phytoscaphus arcticollis Boheman.

This is the only species of *Phytoscaphus* hitherto recorded from the Philippine Islands, and all of the specimens of the genus submitted by Professor Baker appear to be referable to it, for the slight differences observable among them probably represent only local variations.

It would seem that in this insect the median carina on the rostrum is complete only in the female (and then often partly concealed by scaling), whereas in the male it is present only at or near the apex. The thorax is somewhat variable in shape, especially in the male, in which sex it is broader and more strongly rounded at the sides. The male also differs in having the external angles of the interantennal area of the rostrum slightly more prominent than is the case in the female.

It may here be mentioned that the name of this species is wrongly given as *articollis* in Gemminger and Harold's catalogue. It is true that it was so spelled in the text of Schoenherr's Genera

et Species Curculionidum, but it was printed as *arcticollis* in the index to volume 7, and the misprint in the text was corrected in the Corrigenda attached to volume 8, part 1.

Phytoscaphus arcticollis banahaonus subsp. nov.

This race differs from the typical form in having the forehead slightly wider, it being very nearly as wide as one of the eyes; in the apical impression on the rostrum the median carina is entirely or almost entirely obliterated; and the setæ on the elytra are somewhat longer and distinctly more numerous.

Philippine Islands, Luzon, Mount Banahao (*Baker*).

Phytoscaphus arcticollis cretaceus subsp. nov.

In this race the color of the scaling is chalky gray, occasionally uniform, but usually very faintly mottled with pale buff or darker gray.

Differs from the typical form in having the forehead and the dorsal area of the rostrum narrower, the latter being but little wider than the apex of the scape; and the median darker and more rugulose area on the pronotum is absent or very indistinct. In the only female seen (from Leyte) the median carina on the rostrum is much more strongly developed than in the typical form.

Philippine Islands, Mindanao, Iligan, Lanao (*Baker*). Leyte, Tacloban (*Baker*).

HYLOBIINÆ

Seleuca foveicollis sp. nov.

Male and female.—Color black, without scaling.

Head closely and strongly punctate throughout. Rostrum stout, strongly curved, parallel-sided; in male with three straight dorsal carinæ that are equally elevated and disappear toward the base, a narrow, very sinuous lateral carina, a furrow just above the scrobe and continuing a little beyond it, and a fringe of five or six setæ projecting on each side from the lower surface in the apical half; in the female the carinæ are less distinct, the antennæ are inserted a little farther from the apex, and the fringe of setæ is absent. Antennæ with joint 1 of the funicle nearly twice as long as 2. Prothorax as long as broad, very slightly widening from the base to the middle, then narrowing rapidly in front and shallowly constricted near the apex, the apical margin gently sinuate in the middle; the dorsum strongly punctate, but the punctures separated for the most part by spaces that are equal to or greater than their

diameter, and with a large rounded fovea in the middle of the basal half; the discal punctures largest near the base and diminishing gradually in front, but becoming much larger and reticulate toward the sides; laterally each puncture bears a short curved seta. Elytra much wider than the base of the prothorax, parallel-sided from the shoulders to well behind the middle; the striæ broad and deep at the sides and apex, intervals 6 to 10 being narrowly carinate, but striæ 1 to 4 merely punctate and not impressed in the basal half, the intervals there being flat and broad; all the intervals with a row of short stout curved pale setæ; the posterior callus obsolete. Legs black, coarsely punctate and setose; the femora with a single stout tooth placed beyond the middle; the front tibiæ shallowly sinuate internally in the basal half; the tarsi piceous.

Length, 3.9 to 4.8 millimeters; breadth, 1.5 to 1.8.

BORNEO, Sandakan (*Baker*).

Seleuca linearis sp. nov.

Female.—A black scaleless species very similar to the preceding one, but smaller and proportionately much narrower, and differing also in the following characters:

Head separated from the rostrum by a much deeper transverse impression. Rostrum closely and rather rugosely punctate, but without any dorsal carinæ and without any lateral stria above the scrobe. Prothorax a little longer than broad, not constricted at the apex, with the apical margin not sinuate, and the dorsal punctures much smaller. Elytra much narrower, only a little broader than the prothorax, with the lateral striæ quite shallow and only interval 10 narrowly carinate.

Length, 3.3 to 3.9 millimeters; breadth, 0.9 to 1.2.

BORNEO, Sandakan (*Baker*).

Seleuca hispida sp. nov.

Male.—Color black, without scaling.

Head finely and closely punctate, the depression separating off the rostrum rather shallow, as in *S. foveicollis* sp. nov. Rostrum very strongly curved, especially near the base, and slightly dilated at the insertion of the antennæ; viewed laterally, deepest near the base and gradually narrowing to the apex; the whole surface coarsely and closely punctate right to the apex, with three very narrow undulating dorsal carinæ and without any distinct sulcus above the scrobe. Antennæ with joint 1 of the funicle twice as long as 2. Prothorax about as long as broad,

gently rounded at the sides, widest in front of the middle, and constricted at the apex, the apical margin truncate dorsally; the dorsum coarsely and reticulately punctate throughout and without any median fovea; each puncture with a short erect spatulate seta. Elytra much broader than the prothorax, parallel-sided from the shoulders to the middle, then gradually narrowing behind, with a rather deep anteapical impression, but with no prominent callus above it; the discal striæ very shallow and containing large oblong punctures, but becoming much deeper behind and with the punctures almost obsolete; the lateral striæ broadly but shallowly sulcate; the dorsal intervals rather narrower than the punctures, somewhat uneven and becoming rugulose near the base, the lateral ones subcarinate; each interval with an unevenly spaced row of broadly spatulate, erect, whitish setæ. Legs piceous, with the tarsi paler, coarsely punctate and setose; the femora with a sharp erect tooth, placed at about the middle in the posterior pairs and beyond the middle in the front pair, the front tibiæ subangulate internally beyond the middle and strongly curved in the basal half.

Length, 3 millimeters; breadth, 1.2.

BORNEO, Sandakan (*Baker*).

Seleuca saravacana sp. nov.

Male and female.—Integument black, with fairly dense pale buff or brownish gray scaling above; the pronotum covered with rather sparse ribbonlike scales lying transversely, with a broad indefinite denuded median stripe; the elytra more densely squamose, the scales being much smaller than those on the pronotum and broadly truncate at their apices, and the following areas more or less denuded: The whole of intervals 1 and 11, intervals 9 and 10 on the apical two-thirds (except that interval 9 has a small patch of scales on a line with ventrite 3 and another at the apex), and the greater part of the apical declivity; irregularly scattered about the elytra are small groups of erect or suberect scales like those on the pronotum, these being placed close together in single longitudinal rows containing 4 to 10 scales; the lower surface sparsely covered with small hairlike recumbent scales, one in each puncture.

Head with very shallow punctures, each containing a small scale; the transverse impression delimiting the rostrum well marked. Rostrum stout, strongly curved, and parallel-sided, deepest near the base and gradually diminishing to the apex; in the male, rugosely punctate and squamose throughout, except at

the extreme apex, and with three bare, equally raised, narrow dorsal carinæ, the outer ones coalescing with the median at a little distance from the base, and with a broad shallow sulcus just above the scrobe but not extending beyond it; in the female, the rostrum slenderer, slightly narrowing from base to apex, finely punctate on the apical third, and with only the median carina distinct. Antennæ with joint 1 of the funicle as long as 2 + 3. Prothorax about as long as broad, feebly rounded at the sides, widest in front of the middle, and distinctly constricted at the apex, the apical margin gently sinuate in the middle; the dorsum strongly and closely punctate throughout, the intervals being much narrower than the punctures, and without any median fovea. Elytra oblong-ovate, widest a little behind the shoulders and much wider than the prothorax, the lateral outline (as seen directly from above) rather uneven and shallowly sinuous; the posterior calli strongly developed, and a broad shallow transverse depression on each elytron at one-third from the base; the striæ narrowly impressed only at the apex and on the inflexed margin, the dorsal rows of punctures being completely hidden by the scaling; the intervals broad, flat, and (where denuded) finely rugulose, the lateral ones not carinate, and the junction of intervals 3 and 9 at the apex forming a squamose callus. Legs closely and strongly punctate, the scaling dense on the apical half of the femora (especially dorsally) but sparse elsewhere; the femora with a strong sharp tooth beyond the middle and another minute one beyond it; the front tibiæ bisinuate on the inner edge; the tarsi piceous.

Length, 5.4 to 6 millimeters; breadth, 2.1 to 2.4.

BORNEO, Sarawak (*Dr. E. Mjöberg*).

The following key may facilitate the identification of the species of this genus:

Key to the species of Seleuca Pascoe (1871).

1 (6). Front femora with a second minute tooth; elytra clothed with scaling and with the posterior calli well developed.

2 (3). Pronotum with a large round impression in the middle of the basal half .... **S. amicta Pascoe.**

3 (2). Pronotum without any impression.

4 (5). Prothorax gradually narrowed at apex, with separated punctures (the intervals being at least as broad as the punctures), and with a lateral stripe on each side composed of dense subcircular or shortly ovate white scales; elytra with numerous subcontiguous spots of white scales, which are narrowly ovate and pointed at the apex, and without erect scales. **S. leucospila Pascoe.**

5 (4). Prothorax constricted at apex, with coarse subreticulate punctures (the intervals being much narrower than the punctures), and rather thinly clothed with elongate ribbonlike transversely placed buff or gray scales, except for a broad median denuded stripe; elytra fairly densely clothed (except on the suture, the extreme lateral margin, and the posterior declivity) with buff or gray scales which are broadly truncate, and with irregular short longitudinal groups of elongate suberect scales. **S. saravacana sp. nov.**

6 (1). Front femora with only one tooth; elytra without scaling, the posterior calli obsolete.

7 (10). Pronotum with separated punctures on the disk, and a median fovea behind the middle; elytra with narrow setæ, which are recumbent on the basal half and suberect behind; hind femora with the tooth well beyond the middle.

8 (9). Elytra much broader than the prothorax; prothorax as long as broad, constricted at apex, the anterior margin distinctly sinuate in the middle.. **S. foveicollis sp. nov.**

9 (8). Elytra only slightly broader than the prothorax, general form subcylindrical, prothorax somewhat longer than broad, not constricted at apex, the anterior margin not sinuate. **S. linearis sp. nov.**

10 (7). Pronotum with closely reticulate punctures and no median fovea; elytra with broadly spatulate erect setæ throughout; hind femora with the tooth at about the middle................ **S. hispida sp. nov.**

ANTHONOMINÆ

Demimaea bakeri sp. nov.

Male and female.—Integument shining black, with the apical declivity, and especially the apical margin, more or less piceous; the prothorax with sparse suberect setæ, those on the dorsum black, the lateral ones white; the elytra with sparse erect black setæ, a broad thin band of recumbent white setæ across the basal fourth, and another across the top of the declivity, these two being united by a narrow line of white setæ along the suture; the lower surface thinly clothed with short white setæ.

Head with scattered shallow punctures, and a bare smooth patch in the middle of the forehead. Rostrum much deflected, stout, but narrower in the basal third, the dorsal outline moderately curved in the male, less so in the female, the ventral almost straight; with rather coarse shallow punctation, and with five distinct carinæ, the median one being usually rather broader and smoother than the others. Antennæ testaceous brown; the funicle with joint 1 much longer than 2, the remainder beadlike. Prothorax strongly gibbous and inflated dorsally, the anterior slope being much steeper than the posterior one, moderately rounded at the sides, widest a little in front of

217735——6

the middle, only slightly narrower at the apex than at the base, and shallowly constricted near the latter; the dorsum with a shallow transverse depression near the apex and fairly evenly set throughout with rounded punctures, the spaces between which are nearly or quite as wide as the punctures themselves, there being a very indefinite median impunctate line on the anterior half; the sparse setæ on the dorsum and pleuræ all simple, the black dorsal ones longer and more erect than the white lateral ones, but at the basal angles there is a short transverse marginal line of small feathery white scales. Scutellum with very dense feathery white scales. Elytra subtriangular, widest at the shoulders and thence rapidly narrowing to the apex, and with a shallow transverse depression at one-fourth from the base between striæ 1 and 3; the dorsal outline rising gradually from the base to well behind the middle and then sloping very steeply straight to the apex; the striæ shallow, their inner margin forming on the disk a sharp edge (when viewed obliquely from the side), the contained punctures small and widely spaced, but placed much closer together near the base; the intervals broad, smooth, and plane; the white setæ on the basal band all simple, those along the suture and the median part of the declivity all feathery (but a few erect simple white setæ on the latter area), and those at the sides of the declivity simple, bifid, or trifid; on interval 1 behind the middle and on interval 5 just behind the basal white band, a longitudinal tuft of dense dark erect setæ. Legs black, thinly clothed with subrecumbent white setæ, which are mostly simple, but with denser feathery setæ at the apices of the femora and a few at their bases; the femora with a minute tooth; the tarsi and tips of the tibiæ red-brown. Venter with the first visible ventrite flattened in the middle in the male.

Length, 3 to 3.25 millimeters; breadth, 1.6 to 1.8.

Malay Peninsula, Singapore (type) and Penang (*Baker*).

Nearly allied to the genotype, *D. luctuosa* Pascoe (1870), but the latter is a larger insect, with similarly disposed but much denser white clothing; it also differs, inter alia, in having only a single carina on the rostrum; the prothorax is parallel-sided in the basal two-thirds, not gibbous dorsally, and bears larger and closer punctures; and the white bands on the elytra are made up almost entirely of dense feathery setæ.

Faust[1] has quite rightly pointed out that Pascoe was in error in attributing his genus *Demimaea* to the Strangaliodides, but

[1] Ann. Mus. Genova 34 (1895) 224.

the place to which he himself assigned it (in the Gonipterinæ) is almost as unsatisfactory. In Lacordaire's classification the genus would come in the Anthonominæ, among which it has obviously close affinities with Schoenherr's genera *Minyrus, Thamnobius,* and *Pansmicrus.*

ALCIDINÆ

Alcides centroguttatus sp. nov.

Female.—Integument piceous, the prothorax having on each side a rather narrow, very ill-defined, oblique stripe of cream-colored scaling running from the apex (on a level with the upper margin of the eye) to the base opposite interval 5 of the elytra; below this a much broader and denser stripe running obliquely forward from the basal angle to the front of the coxæ, the space between the front coxæ being also densely squamose; the elytra with an elongate pear-shaped patch (1.5 millimeters long) of dense erect blackish scales just behind the scutellum, lying on interval 1 basally and extending on to 2 behind; the rest of the dorsal area thinly clothed with minute narrow pale scales, with an ill-defined blackish band across the top of the declivity, which is narrowest at the suture and widens and curves forward laterally; this band edged anteriorly with a narrow line of pale scaling, which also curves forward at the sides and unites with a small patch of dense scaling on intervals 8 and 9 behind the middle (the patch shorter on interval 9 than on 8); adjoining this scaling in front is a subquadrate blackish lateral patch extending from the side margin to stria 7, and in front of this a small elongate spot of dense pale scaling on interval 11; intervals 9 and 10 with dense scaling at the apex; the metasternum densely clothed with broad fimbriate pale scales, the venter with much sparser small narrow scales.

Head with coarse shallow punctation and rather dense curved fulvous scales; an irregular transverse impunctate ridge across the middle; the forehead flattened and with a low median carina bearing a very small fovea. Rostrum elongate, a little shorter than a front femur, quite cylindrical, almost straight, not dilated at the apex, with coarse confluent punctures in the basal half, and there with a sharp narrow median carina, and on each side of it a broad furrow completely filled with dense suberect fulvous scales. Antennæ with the scape as long as the funicle, joint 1 of the latter shorter than 2 + 3, and 7 slightly longer than the club. Prothorax broader than long, parallel-sided from the base to beyond the middle, and abruptly con-

stricted at the apex; the dorsal anterior margin distinctly arcuate, the postocular lobes feeble and fringed with vibrissæ; the dorsum fairly closely covered with rounded granules, each bearing a very short recumbent seta, the apical area with very shallow distant punctures. Scutellum small, pyriform, broadest behind, not inclosed in front. Elytra subcylindrical, only slightly wider at the shoulders than the base of the prothorax, without any transverse basal depression; the deep rounded foveolæ separated by more than their own diameter, except near the base, where the sculpture is more rugose; the intervals a little broader than the foveolæ, very finely rugulose, and each bearing a row of numerous low shiny granules; the scales forming the pale markings oblong and curved, sometimes fringed at the apex, but never feathery. Legs with rather sparse pale scales, which are denser at the apex of the hind femora and along the lower edge of the anterior pairs; the femora transversely rugulose, the front pair with a large sharp tooth, with four denticles on its anterior edge just like that of A. *pyrifer* Marshall;[2] the middle femora with a similar but smaller tooth, and that on the hind pair still smaller and simple; the front tibiæ only slightly curved dorsally and with a sharp rectangular tooth at the middle of the inner edge.

Length, 8 millimeters; breadth, 3.

BORNEO, Sandakan (*Baker*).

This species in its general facies quite resembles *A. patruelis* Faust (1892), but is readily distinguishable from it and other allied species by the pear-shaped black patch on the elytra, and by the sharp carina and scale-filled sulci on the rostrum; though perhaps the latter characters may be confined to the male sex.

ITHYPORINÆ

Colobodes lophonotus sp. nov.

Male.—Integument black; the head with whitish gray scaling and two large brownish patches on the vertex; the pronotum with dense whitish scaling and with a transverse discal row of four dense erect tufts composed of long stout yellowish white setæ; the elytra with mingled whitish gray and pale brown scaling, and with a very large and long tuft of brown setæ before the middle on interval 3 and a much smaller one at the apex of interval 5; the lower surface with dense grayish white scaling.

Head with very short dense erect scales which conceal the sculpture; the forehead flattened, without any median sulcus,

[2] Ann. & Mag. Nat. Hist. IX 9 (1922) 394, fig. *d*.

covered with broad recumbent scales, and with a row of four erect setæ on each side. Rostrum rather stout, somewhat shorter than the pronotum, only slightly curved, and a little dilated at the apex; the dorsum with shallow reticulate punctures and a fine median carina, the sculpture in the basal half obscured by dense scaling and scattered stout short erect setæ. Antennæ red-brown; the funicle with joint 1 as long as but much thicker than 2, and 3 to 5 moniliform. Prothorax somewhat broader than long, widest near the base, gradually narrowing to beyond the middle, and abruptly constricted and subtubulate at the apex; the base shallowly bisinuate, the basal angles rounded, the apical margin strongly arcuate and much produced dorsally; the dorsum with the punctures hidden by large flat (or sometimes shallowly concave) overlapping scales, with the lateral margins appearing rather flattened and explanate in the basal third owing to the dense scaling being produced over the bases of six stout horizontally projecting setæ; of the four discal tufts of setæ the outer ones are narrower (being obliquely longitudinal), rather shorter, and contain twelve to fifteen setæ, whereas the inner ones contain about twenty-five; on the apical area are scattered erect setæ of varying lengths. Scutellum small, subcircular, bare. Elytra oblong-ovate, appearing to be only slightly broader at the shoulders than the base of the thorax; the striæ shallow and with large shallow punctures dorsally (but much obscured by the scaling) and much deeper laterally; interval 3 with a granulate elevation close to the base, immediately followed by a very large dense conical tuft of stout brown setæ (the longest 1.5 millimeters in length); interval 5 granulate in the basal third and there with a row of six to eight closely placed erect setæ, and with a small elevation at its apex bearing a tuft of about twelve pale setæ; the remaining intervals even and each bearing a row of distant long erect setæ, but intervals 6 and 8 without setæ until behind the middle. Legs with dense, overlapping and often shallowly concave, uniform gray scales and short erect setæ.

Length, 5 millimeters; breadth, 2.4.

BORNEO, Sandakan (*Baker*).

Readily distinguished from the previously described species of the genus by the very long tufts of setæ on the pronotum and elytra.

NOTES ON PHILIPPINE HYDROPHILIDÆ

By A. D'ORCHYMONT
Member of Sociétés Entomologiques de France et Belgique
Mont St. Amand, Belgium

The records of Philippine palpicorns are very meager. The Baer Catalogue[1] includes four species, and Atkinson[2] was acquainted with only five, of which one (*Hydrous ruficornis* Boisduval nec Klug) remains doubtful. Schultze's recent list[3] is not more extensive, for merely eight forms were known at the time his paper was written. Adding to these enumerations the isolated published names brings the total to only a dozen recorded species; all of which seems to indicate that the fauna of these innumerable islands, which must be rich, is practically unknown. We must therefore be thankful to Professor Baker who has organized general and scientific collecting of the insects inhabiting his country, and I am glad that he has been willing to entrust me with the study of his material. When this study was going on I received from Mr. Staudinger and Bang-Haas one lot of nearly six hundred Philippine Hydrophilidæ and another lot, less numerous in individuals, through the kindness of M. R. Peschet of Paris. I have thus been able to draw up a list, already more substantial than that of my predecessors, but am convinced that there remains still much to be done, especially when the interior of the islands, including the smaller ones, shall have been thoroughly investigated.

The study of this material indicates that the hydrophilid fauna of the Philippine Islands has a strong Indo-Malayan character, as could be foreseen, judging by the geographic position of the country.

HYDRAENINÆ

Hydraena (s. str.) **scabra** sp. nov.

Sat curta, parum nitida; capite obscuro, piceo, thorace elytrisque dilutioribus ferrugineis, illo in disco obscuriore; thorace

[1] Ann. Soc. Ent. Fr. VI 6 (1886) 106, 107.
[2] Journ. As. Soc. Bengal 59 (1890) Suppl. 2 (1891) 164–170.
[3] Philip. Journ. Sci. § D 11 (1916) 1–194.

irregulariter sexangulato, crebrius sed minus fortiter ut in *H. pennsylvanica* punctato, lateribus haud profunde foveatis haud explanatis, foveis obliquis prescutellaribus manifestis; elytris explanatis, postice truncatis, punctis quadratis seriatis; palpis pedibusque testaceis.

Type.—My cabinet. Philippine Islands, Luzon, Laguna, Montalban, one specimen, 1.3 by 0.6 millimeters (*Boettcher* leg.).

This species belongs to the group of *palustris* Erichson (Europe) and *pennsylvanica* Kiesenwetter (America), but it is of smaller size, of lighter color, less elongate, having like these forms the anterior margin of pronotum sinuate toward the rear and the pronotum not much narrowed toward the head, but the punctuation of pronotum is finer, denser, and more crowded, the elytra are truncate at the extremity, although they are separately rounded here, they do not cover entirely the abdomen in the only individual at my disposal and are more explanate on the sides than in the compared species.

Head not grooved in the middle basally, of a dark brown color varying to black, rugosely punctate posteriorly. Labrum bilobate. Palpi elongate, the second joint nearly as long as the head, very slender, hardly thicker toward the extremity, third only half as long as second, straight, regularly thickened toward the apex, fourth a little shorter than second, a little thickened beyond the middle and tolerably pointed.

Pronotum of a ferruginous color, darkened upon a transversal quadrangular space in the middle of disk, which does not touch the four sides, having its greatest width beyond the middle, not much narrowed anteriorly, anterior angle decidedly more nearly rectangular than in *pennsylvanica,* the postero-lateral sinus of sides tolerably indicated, before this sinus the sides are not bisinuate; posterior margin nearly straight, anterior margin less deeply sinuate than in *pennsylvanica.* Lateral serration finer. Antero- and postero-external impressions shallow, antero-transversal depression and prescutellar impressions more distinct. Punctuation of pronotum very crowded, the punctures nearly confluent, stretched out longitudinally and separated by a space much narrower than their own diameter.

Elytra of same color as sides of pronotum, a little clearer in the lateral extension, very finely denticulate at the sides, these sides distinctly and tolerably explanate, with a wider lateral channel [4] than in the compared species. Elytral series of punc-

[4] Gouttière of French authors.

tures composed of elongated, nearly quadrangulate punctures, separated in the length as in the width by an interstice much narrower than their dimensions, the longitudinal intervals having thus the appearance of regular, very narrow, and not much elevated lines. Nine series of punctures are present between the scutellum and the humeral callus and in addition five or six between the latter and the lateral margin. Toward the extremity these series become irregular, but yet with good light one can see that the external series remains parallel to the external margin of elytra as far as the posterior truncature of the latter and the internal series is crowded against the external. The elytra are covered with microscopical, very indistinct procumbent hairs. Epipleuron (or false epipleuron) wide but regularly narrowed to the beginning of the posterior truncature.

Prostethium finely and longitudinally carinated in the middle. Glabrous spots of metasternum indistinct or wanting. Middle of metasternum with an elongate and shallow, posteriorly widened impression. Fifth, sixth, and seventh abdominal segments shining (? female). Intermediate and posterior coxæ more separated than the anterior. Legs, including coxæ, and maxillary palpi uniformly of a light ferrugineous color.

SPERCHEINÆ

Spercheus stangli Schwarz and Barber, 1918.

I have not seen Philippine specimens. The typical specimens were captured by Mr. P. Stangl in Luzon, Laguna Province, Bay.

HYDROCHINÆ

Hydrochus annamita Régimbart, 1903.

Of this species, which is also represented in Assam and Tonkin, I have seen good series from different localities in Luzon communicated by Peschet and by Staudinger: Manila, Kavignian, Mount Banahao.

SPHAERIDIINÆ

Coelostoma stultum Walker, 1858.

simplex Sharp, 1874.

This species, very widely distributed in the Indo-Malayan region, including Formosa, was captured in the Philippine Islands by Professor Baker and was received also from other sources: Los Baños, Mount Maquiling, Manila (Luzon); Surigao (Mindanao); also at Catbalogan. It is readily distinguished from the following by the undersurface of its median femora, which

are only provided with sparse short and stiff hairs and not with any dense procumbent hydrofugal pubescence. The interstices of the hairs appear in consequence glabrous and brilliant.

Coelostoma horni Régimbart **lazarense** var. nov.

Late ovale, nitidum, supra nigrum, punctulatum, punctis maxime parvis et sat sparsis, palpis et antennis (totis) rufescentibus; prostethio in medio longitudinaliter tectiformi, antice dentato; mesosternello in medio elevato, parte elevata aream rhomboidalem in medio tectiformem formante; femoribus intermediis subtus dense pubescentibus, posterioribus haud dilatatis, subtus leviter et parce punctato; tibiis posterioribus subtus leviter punctato, tarsis intermediis et posticis haud brevibus; abdominis segmento basali in medio a ponte inter coxas obscure carinato.

Type.—My cabinet. Philippine Islands: Montalban (*Boettcher* leg.), 4.2 by 2.5 millimeters.

This new variety, or perhaps geographical race, seems to be peculiar to the Malayan Islands. I have not received it from elsewhere. Seen from the upper side the beetle seems very like the preceding but is far less punctulate, the most striking differentiating character occurring on the underside of the intermediate femora. Clothed with a silky, procumbent, and very dense pubescence which does not permit one to see the surface of the interstices. This character seems to be of higher than specific rank, for I am acquainted with other species which present it. The Philippine specimens received [Montalban, a good series; Manila (*Baer*), one individual, Philippine Islands (without locality—British Museum)] are much alike. I had taken the first specimen seen for *C. transcaspicum* Reitter, 1906, from Transcaspia, Buchara, Eschitschau-bau, but the type of this species (Budapest Museum) was not accessible. Owing to the kindness of M. Knisch of Vienna I have now been able to study a cotype of *transcaspicum* (Buchara) and another of Novo Saratov (Transcaspia). I can state that the Philippine form is distinct, although Reitter's species presents the same character on the underside of the middle femora. The dorsal punctuation of head, pronotum, and elytra is much finer and sparser than in *stultum, transcaspicum,* and *horni* Régimbart but a specimen from Manila (*Baer*) has the punctuation of elytra, although

sparse and distinctly coarser, and this is even much more the case in two specimens from Palembang (Sumatra) in my collection.

More convex than *transcaspicum* and pronotum less broad and short. Upper side very shining owing to the minute size of the punctures and distinguished chiefly by this from typical *horni*.

Head and pronotum very finely and sparsely punctured, punctures of elytra of nearly same size, more separated from one another, although they are denser around the scutellum; the latter also sparsely and finely punctulate. The shallow sutural stria does not continue to the basal third. Palpi, antennæ, including club, and tarsi rufescent or yellow. Underside including the femora and tibiæ washed with an obscure red tinge. Mentum very smooth, very finely and very sparsely punctulate, with an anterior, very deep, half-round depression. The punctuation of the underside of posterior femora is nearly imperceptible, being truly microscopical. Metasternum not very narrow between the middle coxæ with elevated part forming a narrow and elongate triangular shining area not well defined. First abdominal segment practically not carinate in the middle but with a short, very faint, tectiform longitudinal elevation between the coxæ.

Named for the Isles of S. Lazar, the older name of the Philippine Islands.

Dactylosternum abdominale Fabricius, 1792.

insulare Laporte de Castelnau.
? *nitidum* Boheman, 1851.
rousseti Wollaston, 1854.
? *mulsanti* Murray, 1859.
natalense Gemminger and Harold, 1868.
semistriatus Schaufuss, L. W., 1887.
insulare var. Kuwert, 1890.

Of this species, known from nearly all the warmer regions of the globe, I have seen but one individual from the Philippine Islands, taken at Manila (my cabinet, *Boettcher* leg.). The synonymy of *Cyclonotum mulsanti* Murray [5] is based upon an individual from Kamerun determined by Kuwert, and also in my cabinet. Captured also by Baker at Singapore and Penang Island.

[5] Ann. & Mag. Nat. Hist. III 4 (1859) 352.

Dactylosternum dytiscoides Fabricius, 1775.

melanopterum MONTROUZIER, 1855.
cowleyi BLACKBURN, 1898.

I have seen but one individual labeled "Luzon" in the Deutsches Entomologisches Institut, Berlin, and another from Aru (British Museum) of this widely distributed Malayan species. Known also from Malacca and Ceylon. The synonymy of *Cyclonotum cowleyi* Blackburn [6] is based on a specimen from the typical locality, Cairns, Queensland, kindly sent for my cabinet by Mr. Lea and determined by him. I possess another specimen from Australia, without other locality, and the species has also been found at Sandakan, Borneo, by Baker.

Dactylosternum hydrophiloides W. S. MacLeay, 1825.

? nitidum LAPORTE DE CASTELNAU, 1840.
capense MULSANT, 1844.
rubripes BOHEMAN, 1858.

Described by Boheman as *Cyclonotum rubripes* from Manila and later cited from the Philippine Islands by Baer, Atkinson, Régimbart, and Schultze. I have seen a small series from various localities of this common beetle sent by Baker (one individual, determined as *capense* by Heller), Brussels Museum (one), Staudinger (fifteen); Luzon: Manila, Bayombong, Mount Banahao, Imugan; Leyte; Biliran. Captured also by Baker at Singapore and Sandakan, Borneo, the latter individual immature and wholly reddish.

Dactylosternum subquadratum Fairmaire, 1849.

Luzon: Manila (Brussels Museum, two specimens); Mount Banahao and Imugan (two specimens, *Boettcher* leg.). The specimens have been compared with material of the Fauna Hawaiiensis determined by Sharp. *Dactylosternum subquadratum* seems tolerably variable, even according to the individuals in my cabinet from the Hawaiian Islands. Those of Manila are reddish (immature) and the other two recorded here have the punctuation and scratching of pronotum very much finer, especially the specimen from Mount Banahao. The Imugan one is of more depressed habit, approaching in this respect *D. seriatum* Knisch of Sumatra, Java, Engano, Mentawei, which form is perhaps not entitled to specific rank. There is also a specimen in the British Museum from the Philippine Islands, without exact locality.

[6] Trans. Roy. Soc. South Australia 22 2 (1898) 229.

Subgenus **Coelofletium** novum [7]

Corpus ovatum, sat convexum, prothorace elytrisque perminute reticulatis, indistincte punctatis, antennis novemarticulatis, elytris haud seriatis, haud striatis, abdominis haud carinato.

Type of subgenus, *D. exstriatum* sp. nov.

This form has no striæ or series of punctures upon the elytra, not even a shortened sutural stria, and the upper surface of pronotum and elytra is practically without punctuation. The first abdominal segment has no longitudinal carina. In other respects, facies, and morphology it is a *Dactylosternum*. One could have made of this beetle the representative of a new genus; but, considering that there are true *Dactylosternum* without the least trace of larger punctures arranged to form series (as in *fletcheri* and *coelostomoides* d'Orchymont, for instance) and that the sutural stria even has a tendency to disappear in the latter of these species, I think it not advisable to separate the new form as a genus, but to consider it merely as an extreme differentiation of the very polymorphic natural category under consideration. Besides, the absence of an elevated line on first abdominal segment does not seem to have here the same importance as elsewhere, for the tectiform ridge present in some specimens (the one from Aru, for instance; see below) is certainly representative of this absent carina.

Dactylosternum (Coelofletium) exstriatum sp. nov.

Ovatum sat convexum, haud explanatum, supra nigrum; antennarum clava laxe articulata; elytris perminutissime reticulatis, haud punctulatis, haud seriato-punctatis; prostethii longitudinaliter carinato, antice fortiter dentato; mesostethii parte elevata aream rhomboidalem, in medio longitudinaliter turgidam formante; metasterni parte elevata perminutissime regulariter, denseque punctulata; femoribus intermediis subtus regulariter punctis setigeris sat fortis, parum remotis instructis; tarsorum posteriorum articulo basali secundo tertioque simul sumptis fere aequalibus; abdominis segmento basali longitudinaliter tectiformi.

Type.—My cabinet, Luzon, Laguna, Mount Banahao (*Boettcher* leg.), one specimen; 4.2 to 5 by 2.8 to 3.2 millimeters. Also a short series (British Museum and Brussels Museum) from Manila, all of the same origin, judging from preparation and labeling; a further single individual from Aru in my cabinet.

[7] Name without significance.

Head throughout with very fine microscopical and very close punctulation and with reticulation in the intervals, black, more or less reddish on the prefrons, the Y- and antennal sutures visible only by transmitted light. Labrum transverse, rufescent, anteriorly widely and not deeply sinuate. Maxillary palpi red or yellow, shortened, second joint the longest of all and thickened, third distinctly shorter than second, fourth very little longer. Antennæ 9-jointed, the glabrous part (first disk joints) yellow, the club laxly articulated, yellow or darkened (in the Aru specimen) and longer than joints 2 to 6 taken together. Mentum red or dark, dull, very finely, evenly punctured and microscopically reticulated, widely and semicircularly impressed in front.

Punctuation of pronotum extremely fine, very much finer than on the head, and sparser. Intervals microscopically or more strongly reticulated, each puncture widened by a fine scratch drawn through it. Anterior angles of pronotum rounded, posterior more strongly indicated. Pronotum bordered on the sides and anteriorly behind the eyes more obscurely, not in the middle apically, and posteriorly not at all, even in the region of posterior angles.

Scutellum and elytra practically without punctures, the ground surface microscopically dull, still finer than on pronotum, reticulated or scratched. No sutural stria even posteriorly. Of a dark color more or less bordered with obscure transparent red on sides.

Prostethium strongly carinate in the middle, the carina gradually elevated anteriorly to form a strong tooth. Mesostethial process longer than wide, bordered all round, the sides straight, without acumination anteriorly, the middle tectiform but not sharp, rounded, continued to the metasternum without interruption. Metasternum thin between intermediate coxæ, flattened in the middle and regularly but not very much enlarged posteriorly, with very fine, dense, and regularly distributed punctures. Posterior femora wide, especially at the extremity, where they are prolonged into a lamina covering base of tibia, coated with remote and very fine, indistinct, setigerous punctures, the intermediate with much coarser and very distinct setigerous pores. Tibiæ widened, underside with very fine and remote setigerous punctures. Tarsi short, the posterior a little longer than half the length of corresponding tibia, first joint of posterior tarsus nearly as long as the two following taken together. First abdominal segment not carinate, tectiform in the Aru specimen.

All the Manila specimens seem more or less immature.

Sphaeridium dimidiatum Laporte de Castelnau, 1840.

One individual in my cabinet from Luzon and two others from the Philippine Islands, without exact locality, communicated by the British Museum.

Sphaeridium quinquemaculatum Fabricius, 1798.

vicinum LAPORTE DE CASTELNAU, 1840.
tricolor WALKER, 1858.
chinense FRIVALDSKY, 1889.

LUZON, Mount Maquiling, Los Baños (*Baker*).

Sphaeridium seriatum d'Orchymont, 1913.

Mindanao, Subaan (*Boettcher* leg., two specimens) ; also one specimen captured by Baker at Sandakan, Borneo. This specimen was determined by Heller as *dimidiatum;* it is of small size (5.75 by 3.75 millimeters) and has the subtibial armature of both hind feet composed of three spines.

Cercyon (s. str.) **haemorrhoidalis** Fabricius, 1775.

flavipes FABRICIUS, 1792.
similis MARSHAM, 1802.
picinus MARSHAM, 1802.
nigricollis SAY, 1825.
suturalis STEPHENS, 1829.
femoralis STEPHENS, 1829.
infuscatum STEPHENS, 1829.
apicalis DALLA TORRE, 1877.

One specimen from the Philippines (*O. Koechlin*) in the collection of the Deutsches Entomologisches Institut, Berlin, of this European species. Probably imported.

Cercyon (s. str.) **nigriceps** Marsham, 1802.

atricapillus MARSHAM, 1802.
laevis MARSHAM, 1802.
concinnus MARSHAM, 1802.
centrimaculatum STURM, 1807.
atriceps STEPHENS, 1829.
inustum STEPHENS, 1829.
ustulatum STEPHENS, 1829.
bimaculatum STEPHENS, 1829.
nubilipennis STEPHENS, 1829.
? *pulchellum* HEER, 1840.
mundus MELSHEIMER, 1844.
centromaculatus REY, 1886.

One specimen from the Philippine Islands (*O. Koechlin*) in the collection of the Deutches Entomotogisches Institut and

two from Luzon, Mount Maquiling (*Baker*), of very small size. This form has become nearly cosmopolitan.

Cercyon (s. str.) **vicinalis** Walker, 1859.

Cercyon nigriceps MOTSCHULSKY, 1863.
Cercyon atriceps GEMMINGER and HAROLD, 1868.

LUZON, Mount Maquiling, Los Baños (*Baker*); Manila (*Boettcher* leg.).

Cercyon (s. str.) **lazarensis** sp. nov.

Oblongo-ovalis, sat latus, convexus, niger, maxime nitidus, capite antice, pronoto antice lateribusque anguste, obscure rubro-translucido, infra obscure rubro-niger, abdomine rubro, antennis praeter clava et palpis testaceis. Capite et pronoto sat remote leviterque punctatis; elytris decem-punctato-seriatis, seriebus postice haud canaliculatis, punctis mediocribus haud approximatis; intervallis leviter fere indistincte et laxe punctatis; mesostethii parte elevata angusta, maxime elongata; metasterni parte elevata nitida, sparse et leviter punctata.

Type.—My cabinet, South Luzon: Mount Isrog (*Boettcher* leg.).

Although but one individual is available, I do not hesitate to describe this fine species as new, for I am not acquainted with any oriental form approaching it. The size is great for a *Cercyon* (4.1 by 2.5 millimeters), the upper surface is of a very brilliant black and the elytra have ten series of separated punctures which are nowhere, even at the extremity, deepened into striæ. The sutural series alone becomes a stria before the second third of elytra and is deepened gradually on approaching the extremity.

Head finely and not very densely punctulated, the intervals very smooth, not reticulated even at the base; anterior margin of prefrons finely bordered. Antennal club dark, much longer than joints 2 to 6 taken together; the basal joint nearly as long as the remainder of antenna, including the club. Palpi slender, testaceous, second joint the longest, incrassate toward the extremity, third joint much shorter, fourth nearly as long as the foregoing and of the same size. Mentum reddish, very smooth, and brilliant.

Punctures of pronotum nearly of same size and remoteness as on the head, very shining and smooth in the interspaces. Pronotum bordered on the lateral sides, but not anteriorly or posteriorly; hind and anterior angles rounded.

Scutellum with some minute punctures. Elytra punctured in the interspaces of series like the pronotum and of the same smoothness; the serial punctures are but indistinctly coarser at the extremities; lateral margins of elytra bordered, not explanate.

Prostethium short before the anterior coxæ, longitudinally carinated in the middle; mesostethial lamina very stout and high, the inferior surface of the lamina not being plane, but rounded, of navicular form, attenuated on both ends, and but gradually enlarged in the middle, nearly five or six times as long as its greatest width, shining, smooth, and finely punctulate; elevated part of metasternum pentagonal and shining black with some sparse and fine punctures. No well-defined femoral lines are present on the sides of pentagonal area. Middle of first abdominal segment with well-marked longitudinal carina. Underside of intermediate femora sparsely punctured, posterior still more finely; posterior tibiæ much longer than the corresponding femora and, like the intermediate, nearly impunctate and very smooth on the underside; tarsi slender and long with the first joint of posterior tarsi as long as the three following joints taken together.

Cercyon (s. str.) **secretus** sp. nov.

Late ovatus, paulum convexus, sat depressus, supra et subtus ferrugineus; elytrorum basi saltem tam fortiter punctata quam pronoto; pronoto ad basin haud marginato; subtus metasterno retrorsum acetabularum intermediorum lineas curvas et lineas femorales instructis.

Type.—My cabinet, South Luzon: Mount Isarog (*Boettcher* leg.), 3 by 2 millimeters.

Of wide, depressed, not convex form, entirely (above and below, and appendages) testaceous or reddish, hind portions of the head indefinitely clouded with obscure (post-mortem change ?), club of antennæ also yellow like the base.

Head very smooth and shining, and very finely punctured. Pronotum transversal, scarcely more coarsely punctured than the head, also shining. Anterior angles obtuse but rounded, hind angles obtuse, lateral margins bordered, nearly straight on the anterior four-fifths, then rounded to the posterior margin which is not bordered.

Elytra wide but not expanded, with ten very narrow, tolerably deep striæ bearing fine inserted punctures which become coarser

toward the sides and apex; on the sides anteriorly the striæ are reduced gradually to a series of punctures, the tenth (outer) series is nowhere striiform. Interstitial punctures distinct, much coarser than on the pronotum and head.

Mentum very smooth, nearly impunctate, with a transversal, not well-defined, deep anterior impression; palpi very slender, second joint but little incrassate, third joint nearly as long as the preceding but very much slenderer, fourth nearly as long as the third, also slender. Antennæ with compact, not obscure club, second joint very short, the third to sixth still much shorter and narrower.

Prostethium longitudinally carinate in the middle, but not cultriform: the slopes of carina obliquely ascending to the prosternum where they join an anteriorly converging fold or impression; mesostethial lamina high, anteriorly not abruptly but obliquely raised, undersurface very narrow, linear, not or very slightly incrassate in the middle. Elevated part of metasternum smooth and shining, imperceptibly and irregularly obscurely fine-punctulate, or practically without punctures. Femoral lines ascending obliquely to the extremity of second third of intermediate coxæ and from here on begins a new short line curved and prolonged as far as the middle of metaepisternum. Underside of intermediate femora with fine separated punctures; posterior very narrow and smooth and, like the middle of metasternum, practically without punctuation. Middle of underside of tibiæ with some large, elongated, and oblique spinigerous pores. Posterior tarsi slender, about as long as the corresponding tibiæ; first joint nearly as long as the following three joints taken together.

This fine *Cercyon* is not much akin to any other species I am acquainted with.

Cercyon (s. str.) **lineolatus** Motschulsky, 1863.

Two specimens from the Philippine Islands, without further locality, were communicated by the British Museum. Hitherto known only from Ceylon and India.

Omicrogiton insularis d'Orchymont, 1919.

A single individual of this very rare and interesting palpicorn was captured at Imugan in Luzon (*Boettcher* leg.). Also from Ceylon (Balangoda) in the British Museum.

Genus **PACHYSTERNUM** Motschulsky, 1863

In my opinion, as also in that of von Harold,[8] *Megasternum distinctum* Sharp, 1873, of Japan is the same as *Pachysternum haemorrhoum* Motschulsky, 1866, and the denials of Sharp[9] have not convinced me to the contrary. I have seen a cotype of *M. distinctum* (British Museum) and I may state that it belongs to *Pachysternum,* although the anterior tibiæ are straight on the outer apical margin, not at all sinuate, and only angular in the middle. Motschulsky, when he described *P. haemorrhoum* in 1866, did not state expressly, as Sharp claimed, that his beetle had the front tibiæ emarginate. Motschulsky had stated this three years before, in 1863, when making up the diagnosis of the genus *Pachysternum,* having then before him *P. nigrovittatum,* whose anterior tibiæ are indeed sinuate along the outer apical margin. Besides, the Russian entomologist was apparently not very well acquainted with the niceties of the French language, for he wrote "jambes anterieures echancrées * * *" when the word "sinuées" certainly would have been more in agreement with his observations. When in 1866 he met with *haemorrhoum,* this form in general habit seemed to him to belong also, as it does, to *Pachysternum* and he depended no longer on the tibial morphology. If we accept Motschulsky's description as exact, the only two points cited by Sharp as not agreeing with his *distinctum* are, the first of no great value and perhaps subject to individual variation ("pedibus piceis" according to the Russian author, clearer ferrugineous in Sharp's cotype), and the second inexactly quoted ("elytris * * * interstitiis basi *convexis*" according to Sharp, but Motschulsky wrote *subconvexis,* which is not quite the same). The base of elytral interstices, especially the outer ones, seen under favorable light are in *distinctum* more or less faintly subconvex, not entirely plane; this disposition agrees thus pretty well with Motschulsky's statement. *Pachysternum sibiricum* Kuwert, 1890, of which I received individuals correctly determined and sent to me by von Bodemeyer (Schilka Gora, Siberia Orient.) are very near *haemorrhoum* and, in fact, only differentiated, as stated by Kuwert,[10] by the femoral lines which are interrupted

[8] Deutsche Ent. Zeitschr. 22 (1878) 69.
[9] Ent. Mo. Mag. 15 (1879) 278; Trans. Ent. Soc. London (1884) 462.
[10] Verh. Naturf. Ver. Brünn 28 (1889) 171.

before attaining the hind coxæ near the middle of metasternum. I think that *sibiricus* is only a slight variation of the Japanese form.

This comparative study was necessary in connection with the preparing of the description of the following new Philippine species.

Pachysternum curvatum sp. nov.

Ovatum, valde convexum, nitidum, nigrum, vel obscure brunneum, postice dilutior, intervallis suturalibus omnino nigris; antennis basi, palpis pedibusque rufis; elytris profunde et anguste punctato-striatis, interstitiis subtilissime haud crebre punctulatis; tibiarum anticorum margine exterius regulariter curvatis, haud sinuatis, haud rectis; prostethii parte elevata in medio longitudinaliter carinata.

Type.—My cabinet, Luzon: Imugan (*Boettcher* leg.). Also a male cotype of same origin and another individual from Mount Banahao, with the above. Size 2.1 to 2.5 by 1.7 to 1.9 millimeters.

This species is very near to *haermorrhoum* and *sibiricum*, the comparison giving the following results: *curvatum* is of wider and shorter form, the ground punctuation of pronotum is finer, the coarser intermingled punctures therefore more distinct; elytra more shining and smoother, with the ground punctuation finer, the striæ, especially the internal ones, deeper and narrower, more clear-cut, with the inserted punctures much finer (in *haemorrhoum* and *sibiricum* these punctures are larger and the internal striæ are more like a series of punctures); mesostethial plate less rugosely punctured; metasternum with finer punctures; anterior tibiæ not so abruptly and strongly widened in the middle with outer margin regularly curved and with uninterrupted rows of marginal spines; in compared forms this margin has anteriorly, between middle and apex, two very obtuse angles, between which angles the margin is straight, not curved, and the marginal spines are wanting; it is by this character that these two forms were placed by their authors in *Pachysternum* (they seem to have overlooked that the punctuation of pronotum is composed of punctures of two sizes). *Pachysternum apicatum* has also a fine ground punctuation upon the pronotum, but the greater size of this Indian and Sumatran species and the widened anterior tibiæ, with outer margin partly straight, will immediately distinguish it.

Of wide, posteriorly much attenuate form, of a deep black color in the type, only ill-defined reddish on the anterior parts and middle of the head, on the lateral and anterior parts of pronotum and on the apex of elytra; yet the sutural interval remains black nearly to the extremity of the wing cases. In the two cotypes the dark parts are washed with very obscure brown.

Head densely punctured, the punctures of one size and not very fine, the interstices shining.

Pronotum with a background of very fine punctures, and with much coarser, remotely intermixed punctures, which become denser toward the sides, the posterior margin with a row of still coarser punctures on its edge.

Elytra very indistinctly, microscopically pubescent, with basic punctuation very fine, becoming gradually coarser toward the sides, with ten finely cut striæ which become weaker posteriorly and which bear toward the extremity diminishing striæ, and fine punctures which become coarser toward the sides; the tenth (outer) stria is much more deeply impressed than the others.

Mentum rugosely punctured. Prostethial plate rugose, bordered anteriorly and at the lateral sides, longitudinally carinated in the middle; mesostethial plate pentagonal, a little wider than long, rugosely punctate, with the ordinary posterior triangular excision; metasternum in the middle with not very coarse punctures, femoral lines not distinctly interrupted near posterior coxæ at middle of metasternum. Last ventral segment examined in the male cotype reddish, shining like the foregoing, with the exception of the first, which is rugosely and densely punctate and longitudinally carinate in the middle.

Male genital armature symmetric, with long embracing lateral lobes and tolerably broad median lobe which is shortly and triangularly pointed at the extremity.

HYDROPHILINÆ

Genus **PARACYMUS** Thomson, 1867

Entomological students have paid but little attention to these obscure little beetles and the descriptions are frequently insufficient and in many cases the ventral side has never been studied. The determination of the Philippine material has thus obliged me to reëxamine the species of the old world (Europe, Asia, Africa, Australia, and New Caledonia) with the material in my collection and, as far as possible, when none such were available,

the literature only. Of these forms *Paracymus rufipes* Guillebeau, 1896, from Syria, must certainly be removed from the genus having, according to description, all the femora densely pubescent. It must be a representive of *Anacaena*. *Paracymus metallescens* Fauvel, 1883, from New Caledonia is perhaps the same as *P. pygmaeus* W. S. MacLeay, 1871, from Australia, but no material from the original country could be seen; it may be added that Fauvel stated that his beetle occurred also on the Australian continent.

Most authors, with the exception of Fall, for *P. subcupreus* Say from North America,[11] seem to have overlooked that the male's fifth joint of anterior tarsi is sometimes provided with a very small tooth; the preceding joints of the same tarsi are also wider and shorter, more moniliform than in the female and in some species, *P. nitidiusculus* Brown (=*pygmaeus* W. S. MacLeay sec. Blackburn) for instance, the joints of first male tarsi are gradually, and especially the fourth and fifth, a little laminated toward the extremity of underside.

All the non-American forms are known to possess but 8-jointed antennæ; in the American species the number of these joints varies from seven to nine. I possess in my cabinet a specimen of *P. apicalis* Reitter from East Siberia (Sotka Gora) with 9-jointed antennæ. This important character was not seen by Reitter. Finally, the species inhabiting the Oriental Region and Australia known to me all have a longitudinal carina in the middle of first ventral segment. This is perhaps the reason why W. S. MacLeay described *pygmaeus* as a *Cyclonotum*, although it is not at all certain that the character alluded to was observed by him. A ventral carina is very rare in the Hydrophilinæ and occurs on the contrary very frequently in the Sphaeridiinæ.

Summing up all these differentiations we may be able now to take the first step toward the classification of these difficult forms. The following key comprises only such known forms as I have been able to study in nature, according to correctly named material.

Key to known species of Paracymus Thomson.

1. Antennæ 9-jointed. Prostethium very long before the anterior coxæ, not carinate at all. First ventral segment without carina in the middle. Intermediate femora with basal pubescence reaching beyond the middle. Mesostethium nearly unarmed, with only a slight tuber-

[11] Fall, Occasional papers, Calif. Acad. Sci. 8 (1902) 218. No tooth is present in the male of the Bolivian *P. attenuatus* and *obliquus* d'Orchymont.

culiform elevation before the intermediate coxæ, and without transversal ∧ crest. Posterior margin of pronotum very distinctly bisinuate. (Siberia.) .... P. apicalis Reitter.
Antennæ 8-jointed. Prostethium more or less longitudinally tectiform or carinate along the middle .... 2.
2. First ventral segment not carinate in the middle .... 3.
First ventral segment longitudinally carinate. (India, Seychelles, Australia.) .... P. evanescens Sharp.
P. alluaudianus H. Scott.
P. pygmaeus W. S. MacLeay.
3. Intermediate femora with basal pubescence reaching beyond the middle of femora. Tibiæ of obscure color .... 4.
Intermediate femora with basal pubescence not reaching beyond the middle. (Europe, Siberia, Caucasus.) .... P. aeneus Germar.
P. relaxus Rey.
P. schneideri Kuwert.
4. Mesostethium with a fine longitudinal carina posterior to the transverse ∧ crest. (Asia Minor, Transcaucasia.) .... P. caucasicus Kuwert.
Mesostethium without conspicuous longitudinal carina or with a very small one, but then the punctures of elytra are very fine and geminate under high power .... 5.
5. Elytra with normal punctures of a tolerable strength. (Europe.)
P. scutellaris Rosenhauer.
Elytra with much finer and remoter punctures; seen under a high power these punctures seem to be double, like a minute figure 8, as though two punctures were coalescing, or resembling umbilicated punctures, also of much smaller size. (Mediterranean, France.)
P. punctillatus Rey.

Other species still unknown or insufficiently known to me are: *P. chalceolus* Solsky, 1874, from Turkestan; *chalceus, liliputanus,* and *minor* Régimbart, 1903, from Madagascar; *nigerrimus* Blackburn, 1891, from Australia. I possess a *Paracymus* from Guinea determined as *cybocephaloides* Reitter in litt., which name, according to Knisch,[12] should apply to the *P. minor* of Régimbart. However, in my specimen the pubescence of the intermediate femora does not reach beyond the middle, as it does in the Madagascan species, the type of which has been examined by H. Scott.[13]

Paracymus evanescens Sharp, 1890.

Two specimens, one from Montalban, the other from Manila (*E. Simon*), seem to belong to this species. They have the same small size (scarcely 1.5 millimeters) and the same kind of dorsal punctuation, the upper side being of a deep black and not brassy;

[12] Archiv. f. Naturgesch. (1919) 67.
[13] Trans. Linn. Soc. London XVI 2 (1913) 202.

they show but few points of variation as compared with a cotype from Kandy. This cotype is probably the same seen by H. Scott, for Sharp had only two specimens at his disposition; but I must confess that I have not been able to see clearly the gemination or umbilication of the punctuations of elytra as described by H. Scott (which appeared to him as a small figure 8). With a good microscope of high resolving power and without artificial light the punctuation appears simple; only with artificial light the punctuations appear here and there to be geminate, but at any rate far from distinctly so, as is the case in *punctillatus* Rey where the punctuations (65 diameters; binocular Zeiss) are very much finer and appear clearly as if two punctures were coalescent. I think that this appearance is to some extent only an optical illusion. I have also seen a specimen from Adelaide River and another from Port Darwin (Australia, British Museum) of the usual small size, which belong also, I think, to this species.

I have studied a far more numerous series from Manila (*Baer, Boettcher,* leg.) and one from Los Baños (*Baker*) which may be treated as a variety of *evanescens.* By their greater size (1.8 to 2 millimeters), their coarser dorsal punctuation, their more obscure dorsal color, only faintly fuscous at apex of elytra and at the anterior angles of pronotum, they approach *pygmaeus* MacLeay from Australia. The punctuation on the sides of elytra is also more distinctly geminate than in *evanescens;* they may represent a geographical race of the latter and I have named them *orientalis* var. nov.

It is impossible not to feel some doubt as to the specific validity of such difficult forms as *evanescens, pygmaeus,* etc., and I have hitherto failed to detect good discriminating characters.

Paracymus punctillatus atomus var. nov.

This form is of smaller size (1.1 to 1.2 millimeters), black, not brassy or metallic, upper side with punctuation, especially of elytra, far less distinct, finer, otherwise very similar; antennæ 8-jointed, first abdominal segment not carinate, intermediate femora with pubescence reaching beyond the middle, mesostethium between middle coxæ with a very fine, indistinct, longitudinal carina beyond the transversal $\wedge$ crest, elytra with microscopically geminated punctures.

Montalban, two specimens (*Boettcher* leg.). I have seen this form also from Singapore (*Saunders*), Madagascar, Tananarive, East Africa, and Belgian Congo (Banana-Boma,

Tschoffen). It seems thus very widely distributed. I have treated it as a mere variety of Rey's species for I am acquainted with only a single specimen of *punctillatus* Rey from Nizza, the typical locality, and am not well informed as to its variation. Régimbart recorded the species as abundant in East Africa, but his statement may perhaps refer to the present variety. According to Rey and Ganglbauer the type species is, like my specimen, of greater size (1.6 to 2.2 millimeters) and of brassy color.

Helochares (Hydrobaticus) anchoralis Sharp, 1890.

A good series from Manila (*Boettcher* leg.) and also three specimens from Los Baños (*Baker*).

Helochares (Hydrobaticus) crenatus Régimbart, 1903.

Seems also abundant in its haunts; Luzon; Los Baños, Paete, Balbalan, Montalban (*Boettcher* leg.).

Helochares (Chasmogenus) livornicus Kuwert, 1890.

abnormalis SHARP, 1890.
mollis RÉGIMBART, 1903.
? *ferrugatus* RÉGIMBART, 1903.
abnormicollis ZAITZER, 1908.

I refer to this species one specimen from Mount Maquiling, Luzon (*Baker*); another from Manila and a third from Mount Banahao, also in Luzon (*Boettcher* leg.), of very obscure tinge.

Helochares (s. str.) taprobanicus Sharp, 1890.

atropiceus RÉGIMBART, 1903.

One specimen captured by Baker on Mount Maquiling in Luzon and another at Sandakan, Borneo.

Helochares (s. str.) pallens W. S. MacLeay, 1825.

minutissimus KUWERT, 1890; RÉGIMBART, 1903.

Enhydrus pallens MacLeay is cited under *Enochrus* (*Lumetus*) in the catalogues; I do not know why. Two frequently very pallid Hydrobiini of the size indicated by the old author (3/32 = 2 millimeters 4/10) are very common in the Oriental Region and represented in nearly all the invoices received from the East Indies; namely, *Enochrus escuriens* Walker and *Helochares minutissimus* (Kuwert) Régimbart. The former has the head of a deep black color which is not in accordance with MacLeay's statement: "E. albicans * * *" The very short original description terminates as follows: "thorace maculis quatuor obscuris transverse dispositis elytrisque obsolete striatis." By the last

three words are intended in my opinion the infuscated longitudinal lines which correspond to the longitudinal rows of punctures of underside of elytra and are seen by transmitted light. I have not seen Arabian or Syrian specimens and so cannot state if Régimbart was correct in his identifications. I have already expressed doubt as to this.

Helochares (s. str.) **pallens insolitus** var. nov.

Among the *Helochares* sent by Staudinger there is a troublesome specimen from Manila which differs only from the very common, always pallid *pallens* by the dark blackish color of upper and underside, the black palpi and legs, and by the dorsal sculpture of elytra and thorax being visibly coarser. I am not able to find other differences; the fifth abdominal segment is also emarginate-ciliate at the apex and the mentum and submentum are coarsely sculptured as in *pallens*. The individual is in a decayed state, having lost all its tibiæ and tarsi; it looks as if it belonged to a different species but the material is insufficient to decide now. So, the specimen being in the meantime worthy a name, I leave it as a variety of *pallens*.

Pelthydrus minutus d'Orchymont, 1919.

This very minute and good species was described from a single specimen from Palembang, Sumatra. I have received since from Staudinger four other examples captured at Montalban, Philippine Islands. One of these and also the type have the maxillary palpi a trifle shorter, in the other specimens especially the second joint when seen from above. Possibly this may be a sexual character, but I have not been able to settle the matter, for, on account of paucity of material, I did not dare to risk dissection.

Enochrus (s. str.) **fallax** sp. nov.

Late ovalis sat convexus, nitidus, ferrugineus, capite in medio anguste longitudinaliterque, prothorace sat late in disco, elytris fere toto, infuscatis; antennis basi, palpis testaceis, pedibus ferrugineis; prothorace, praesertim capite subtiliter, crebreque punctatis, elytris etiam subtiliter punctatis, his duobus seriebus internis systematicis (secundariis) irregulariter bene distinctis, seriebus primitiis maxime subtilius, in intervallo plus minusve distinctis, segmento abdominali quinto postice in medio perminute emarginato et ciliato.

Type.—My cabinet, Montalban (*Boettcher* leg.), one specimen, 2.6 by 1.6 millimeters.

Of a ferrugineous color indefinitely infuscated in the middle of prefrons narrowly, on the postfrons wholly, on median third of pronotum nearly, and on elytra with exception of the sides, a wide space becoming gradually wider behind near the suture; in this ferrugineous band posteriorly are transparent black punctures of the primary series. The shape of the beetle is widely oblong with the sides nearly parallel and the apex of elytra broadly rounded.

Head with the transversal and sagittal sutures present as fine impressed lines, on the inner side of the eyes are present a few very irregular larger punctures, the largest of which are near or upon the transversal suture; the punctuation of the upper surface of head is very fine, almost microscopical. The labrum is very short and broad with punctures of nearly the same size; the eyes are not at all prominent; maxillary palpi with second joint nearly straight, the third joint much shorter, the fourth about of same length as the third and bent outward as usual; antennæ short with the club infuscate, nearly as long as joints 2 to 6 taken together, the last joint as long as the two preceding pubescent joints of club taken together.

Punctuation of pronotum as fine as on the head, perhaps a trifle coarser; pronotum finely bordered on the sides, this border being continued very finely on the anterior but not on the posterior margin; anterior and posterior angles rounded, the former distinctly more so than the latter; the two lateral regular rows of punctures are discernible but the punctures are not so large as on the head.

Base of elytra as wide as posterior margin of pronotum, elytra bordered on the sides very narrowly especially posteriorly toward the suture, sculpture a trifle less microscopical with the two inner rows of punctures very irregular, but well marked; round these one can see the very small and fine punctures of the very regular primary series, two on their interval, one near the suture, and several others laterally. Near the lateral margin the punctures become indistinct and more or less intermingled with those of the not very conspicuous outer (third) row, the punctures becoming here a little coarser. Sutural stria well impressed, ascending to the scutellum at a distance only a trifle greater than its own length.

Mentum a pentagon nearly as long as wide, finely sculptured or dull on its anterior two-thirds, broadly but very shallowly impressed there, more shining behind. Prostethium pointed before, tectiform but not carinate in the middle; mesostethium

with a not very high nor very acute carina before the middle coxæ, declivous anteriorly; metasternum depressed on both sides to allow movement of hind femora. Ventral segments, fore and middle femora with exception of knees, coated with hydrofugal pubescence, the hind femora with only scattered setæ and only with some pubescence on the inner foreside. Femora and tibiæ robust for the small size of the insect, the tarsi slender and very much shorter than their corresponding tibiæ.

This new species is of the size of *E. peregrinus* Knisch from New South Wales, but the latter form is darker and is said to have no regular rows of punctures on elytra.

Enochrus (Lumetus) escuriens Walker, 1858.

nigriceps MOTSCHULSKY, 1859.

Cited already from the Philippine Islands by Régimbart and by Schultze. Specimens were seen from Luzon, Manila, and Antipolo. Very common species in the Oriental Region.

Enochrus (Lumetus) malabarensis Régimbart, 1903.

LUZON, Manila, Lanao, Mount Banahao (*Boettcher* leg.).

I have carefully compared the specimen with a typical specimen of *malabarensis* (from Calicut, India) in my cabinet and cannot point out any differences.

Enochrus (Lumetus) fragiloides sp. nov.

Sat late ovalis, sat depressus, politus, obsolete punctatus, testaceus, vertice et elytrorum intervallo interno postice ad suturam nigricantibus, labro haud nigricante, subtus plus minusve infuscatus, segmento abdominali quinto postice in medio emarginato et ciliato.

Type.—My cabinet, Luzon, Los Baños (*Boettcher* leg.), 3 by 1.6 millimeters. Several cotypes from the same locality sent by the same, and also one from Manila. Size varying from 3 to 3.3 millimeters.

Comes very near to *fragilus* Sharp of Ceylon, of which I have seen a cotype, and to *icterus* Knisch from W. Almora (India). From the first it is distinguished by its broader and shorter shape, the convexity being less, and its smaller size; from the latter it may be roughly separated, according to description, by the entirely pallid labrum, the ordinary infuscated sutural interval in its posterior part, the systematic punctures of elytra being not strongly developed, the anterior dentation of mesostethium being not directed backward.

Head more or less transverse, of a reddish yellow, infuscated behind the transversal suture and also more or less triangularly in the middle of prefrons behind against this suture. Punctuation very fine, regular punctures on the same suture and behind this on each side against the eyes distinctly coarser. Anterior margin of prefrons with slight and shallow emargination in the middle behind labrum; this behind with punctures a trifle denser and coarser than the basic punctures of prefrons and arranged in a somewhat transversal manner. Palpi entirely yellow.

Basic punctures of pronotum of nearly the same size and spacing as on the head; pronotum at base nearly twice as broad as long in the middle. Anterior angles very much rounded, the posterior less so, the delicate lateral border being continued very obscurely along the anterior margin. Regular rows discernible but composed of very fine punctures scarcely twice as large as the basic punctuation.

Scutellum and elytra as indistinctly punctured as pronotum with the regular rows composed of faint punctures; only the sutural interspace is ordinarily infuscated behind and sometimes there is also a black mark on the shoulders.

Mentum shining, with some scattered, not very coarse punctures. Prostethium obscurely tectiform in the middle. Mesostethium with a vertical lamina not very highly developed and in front with a little tooth directed toward the surface. Metasternum on each side obliquely depressed to allow movement of hind femora; the latter are not very broad and all are densely coated with hydrofugal pubescence, the knees excepted. Tibiæ and tarsi of a red-brown color, the former not very broad, the latter rather slender.

Enochrus (Lumetus) rubrocinctus Régimbart, 1903.

bakeri A. D'ORCHYMONT, in coll.

LUZON, Burauen, Manila, Mount Maquiling. LEYTE. BURU ISLAND in the Malayan Archipelago. Calcutta, Berhampore (Bengal). The punctuation of pronotum is highly variable but I am convinced now, though I have not seen typical examples, that it is the species of Régimbart described from Indo-China, India, and Sumatra.

Chaetarthria indica d'Orchymont, 1920.

Several specimens of this species were obtained from Montalban and sent by Staudinger. I cannot separate these speci-

mens from the Indian ones. Besides, I think that *C. almorana* Knisch, 1924,[14] is merely a synonym of this form. The two descriptions agree well as I have described the punctures on outer side of elytra as "mal indiques" the one or two series so formed being very inconspicuous and short, although under a high power and favorable light they seem more or less regular. But this is subject to variation as is also the color of legs. In the Indian specimens the femora and tibiæ are of an obscure reddish brown, with the tarsi more diluted; but practically the upper surface of elytra is, as stated by the Austrian author, "glatt, sehr stark glänzend, sculpturlos." The size also is subject to variation. Another country for this species is Tonkin (*Dr. Santschi* leg.).

Sternolophus (Neosternolophus) brachyacanthus Régimbart, 1902.

LUZON: Manila, Lamao (*Boettcher* leg.), two specimens Already cited from the Philippines by me in 1919.

Sternolophus (Neosternolophus) tenebricosus (Blackburn), d'Orchymont, 1911.

LUZON: Paete (*Boettcher* leg.), two specimens.

Sternolophus (s. str.) rufipes Fabricius, 1792.

This species is already known from the Philippines through Baer and Atkinson.

LUZON, Los Baños (*Baker*), Zambales, Kavignian (*Boettcher* leg.). Very common throughout the Oriental Region.

Neohydrophilus spinicollis elongatus Régimbart, 1902.

One male and one female from the Philippine Islands sent for examination by the British Museum and one specimen captured by Baer (*Peschet* coll.). Régimbart has already cited *spinicollis* from these islands.

Hydrous (s. str.) picicornis Chevrolat, 1863.

Cited already by Baer, Atkinson, Kuwert, Régimbart, and Schultze.

LUZON, Zambales, Manila (*Boettcher* leg.); also Los Baños (*Baker*).

Amphiops mirabilis Sharp, 1890.

One specimen secured by E. Simon at Manila. This species is known from Ceylon, India, Indo-China, Sumatra.

[14] Wien. Ent. Zeit. 41 (1924) 39.

Amphiops ? sumatrensis Régimbart, 1903.

A single specimen labeled Manila (*E. Simon*) which seems to belong here. In several cases these difficult beetles do not seem capable of certain determination and a thorough revision of the genus is needed.

Berosus (s. str.) **pulchellus** W. S. MacLeay, 1825.

pubescens MULSANT, 1859.
decrescens WALKER, 1859.

Already known from the Baer, Atkinson, Régimbart, and Schultze writings.

I have seen specimens from Manila and Kavignian, Luzon.

Berosus (s. str.) **affinis** Brullé, 1835.

One specimen labeled "Philippines" in the Deutsches Entomologisches Museum, Berlin. Seems very doubtful. Imported?

Berosus (Enoplurus) indicus Motschulsky, 1861.

Cited by Régimbart, and by Schultze after him.

Specimens were studied from Luzon: Los Baños (*Baker*), Manila, and Kavignian.

Berosus (Enoplurus) fairmairei (Zaitzer) d'Orchymont, 1913.

LUZON, Laguna, Los Baños (*Baker*). Surigao and Manila (*Boettcher*). Also at Mindanao. Others were also captured at the last-named locality by Baer and Simon.

Régimbartia attenuata Fabricius, 1801.

aenea BRULLE, 1835.

Already known from the Philippines, according to Régimbart and Schultze.

Several specimens were received from Luzon: Manila and Kavignian.

The above complete list comprises forty-nine forms. Ten of these are new to science and eight of them peculiar to the Philippine Islands. Twenty-five genera or subgenera are represented, of which one (*Coelofletium*) was hitherto unknown. I am convinced, as already stated, that this is only a small part of the existing Hydrophilidæ of these islands.

DIE TENEBRIONIDEN (COLEOPTERA) DES INDO-MALAYISCHEN GEBIETES, UNTER BERUECKSICHTIGUNG DER BENACHBARTEN FAUNEN, IX

KORREKTUREN

Von Hans Gebien
Hamburg, Deutschland

Die oben genannte Arbeit ist schon im Dezember 1920 abgeschlossen gewesen und nach Manila gesandt, aber erst 1925 erschienen. In der Zwischenzeit sind einige Arbeiten über Tenebrioniden veröffentlicht, deren Resultate natürlich nicht berücksichtigt werden konnten. Im Laufe dieser Zeit ist mir auch sehr viel Material, besonders von den Philippinen, in die Hände gelangt. Dass dieses, obgleich ich es den Sammlern bestimmt habe, in der Arbeit fehlt, ist aus dem obengenannten Grunde zu erklären. Leider habe ich vor der Drucklegung nicht Korrektur lesen können. Es sind daher zahlreiche, sehr störende Druckfehler stehen geblieben, die man nicht mir zur Last legen möge. Von einer Berichtigung dieser Fehler, habe ich hier Abstand genommen.

PHILIPPINE JOURNAL OF SCIENCE, VOLUME 26, 1925

Seite 68, Zeile 11, zum Beispiel ist auszulassen.
Seite 68, Zeile 40, *statt* auch ihm *lies* auch ihnen.
Seite 72, Zeile 45, *statt* Helom.-Arten *lies* Helops-Arten.
Seite 76, Zeile 21, *statt* Aber diese Merkmale *lies* Diese Merkmale.
Seite 79, Zeile 12, statt *Opatium*-ähnlich lies *Opatrum*-ähnlich.
Seite 423, Zeile 21, *statt* ungehäutet ist *lies* ungekantet ist.
Seite 438, Zeile 24, statt *Bolitoplegus vacca* lies *Bolitophagus vacca.*
Seite 537, letzte Zeile, *statt* erscheinen an anderer Stelle *lies* sind an anderer Stelle erschienen.
Seite 538, Zeile 6, *statt* flachen, weitläufigen Körnchen *lies* flacher, weitläufiger Körnchen.
Seite 538, Zeile 45, *statt* **B.** celebensis sp. nov. *lies* celebensis nom. nov.
Seite 543, Zeile 8, *statt* schlanke Tiere *lies* schlanke Formen.
Seite 546, Zeile 9, *statt* **B.** celebensis sp. nov. *lies* celebensis nom. nov.
Seite 548, Zeile 17, statt *Opatrium serricolle* lies *Opatrum serricolle.*
Seite 565. Zeile 3, Mit dem Wort Ausser muss ein neuer Absatz beginnen.
Seite 566 Zeile 15, *statt* anicorum *lies* amicorum
Seite [illegible], Zeile 24, *statt* pici Chatin *lies* pici Chatanay

PHILIPPINE JOURNAL OF SCIENCE, VOLUME 27, 1925

Seite 131, Zeile 26, statt *Glyxerus* lies *Ilyxerus*
Seite 131, Zeile 31, *statt* Solander *lies* Solier
Seite 132, Zeile 26, *statt* Solander *lies* Solier
Seite 132, Zeile 35, *statt* fest auf der Stirn *lies* fast auf der Stirn
Seite 133, Zeile 23, 26, 27, statt *elongatus* Redtenbach lies *elongatus* Redtenbacher
Seite 133, Zeile 31, *statt* Das Weibchen unterscheidet sich vom Männchen *lies* das Männchen unterscheidet sich vom Weibchen.
Seite 134, Zeile 2, statt *Dysantes biluna* lies *Toxicum biluna.*
Seite 135, Zeile 22, *statt* Halopiden *lies* Helopiden
Seite 137, Zeile 36, statt *Parta* lies *Païta*
Seite 140, Zeile 20, statt *Platydema* lies *Platydemen*
Seite 141, Zeile 26, statt *Platydema* lies *Platydemen*
Seite 144, Zeile 20, *statt* **B. hellus** *lies* **B. helluo**
Seite 146, Zeile 24, *statt* Pelobo cas *lies* Pelobocas
Seite 147, Zeile 35, *statt* **Basanus sumatranus** *lies* **Basanus sumatrensis**
Seite 152, Zeile 10, *statt* **Basanus hellus** *lies* **Basanus helluo**
Seite 154, Zeile 24, statt *B. hellus,* lies *B. helluo*
Seite 264, Zeile 13, *statt* etwas anderes *lies* nicht anderes
Seite 274, Zeile 26, *statt* einschlüssige Litteratur *lies* einschlägige Litteratur
Seite 276, Zeile 25, *statt* Graveley *lies* Gravely
Seite 288, Zeile 6 und 7, *statt* **Ceropria yris** *lies* **Ceropria iris**
Seite 423, Zeile 18, *statt* wie alle Diaperiden *lies* wie fast alle Diaperinen
Seite 433, Zeile 1, *statt* deren gänzliches Fehlen *lies* derem gänzlichen Fehlen
Seite 435, Zeile 4, *statt* beim Männchen nur *lies* beim Weibchen nur
Seite 542, Zeile 33, *statt* schärg erweitert *lies* schräg erweitert
Seite 542, Zeile 38, *statt* das linke Horn *lies* das rechte Horn
Seite 545, Zeile 31, *statt* halbgerandet *lies* hellgerandet
Seite 560, Zeile 30, *statt* ungebrochenes Gabelhorn *lies* umgebrochenes
Seite 564, Zeile 17, *statt* Beim Männchen *lies* beim Weibchen
Seite 565, Zeile 7, *statt* Burma, Peger *lies* Burma, Pegu
Seite 583, Zeile 32, statt *P. malaccum* lies *P. detersum*
Seite 583, nach Zeile 39, schalte ein *Ceropria valga* Pascoe, Ann. & Mag, Nat. Hist. IV 3 (1869) 281.
Seite 586, Zeile 8 bis 28 (zweiter und dritter Absatz) gehören ans Ende von Seite 585.
Seite 586, Zeile 28, statt *Ceropria salga* lies *Ceropria valga*
Seite 590, Zeile 39, *statt* und der den Flügeldecken ausschliessende *lies* und der sich den Flügeldecken anschliessende
Seite 592, Zeile 40 und 41, *statt* **Basides crassicornus** *lies* **Basides crassicornis**

PHILIPPINE JOURNAL OF SCIENCE, VOLUME 28, 1925

Seite 115, Zeile 37, *statt* weil aber die meisten *lies* weil eben die meisten
Seite 116, Fussnote *lies* Lesne, Bull. Soc. Ent. Fr. (1915) 189.

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 30 AUGUST, 1926 No. 4

ADDITIONS TO OUR KNOWLEDGE OF THE PHILIPPINE FLORA, III [1]

By ELMER D. MERRILL

Of the University of California, Berkeley

This, the third paper of the series, lists forty-seven species as new to the flora of the Philippines, including thirty-two which are herein described as new. One new name and two transfers are also published for the first time. Eight previously described genera are recorded for the first time from the Archipelago; namely, *Koordersiochloa, Baphia, Fordia, Merope, Xanthomyrtus, Anplectrum, Peucedanum,* and *Zanonia.*

The bulk of the species considered in this paper are from the extensive collections made by Messrs. Ramos and Edaño in Jolo and Tawitawi, Sulu Archipelago, in 1924. Neither island had previously been explored botanically, only casual collections having been made in this region. As usual in cases of this kind, where extensive collections are made for the first time in a previously unexplored region, the number of forms of special interest and value is great. From the proximity of the Sulu Archipelago to Borneo, as naturally would be expected, a fair number of the additions represent Bornean types or forms allied to Bornean species.

The actual types are deposited in the Bureau of Science herbarium, with duplicates in the herbarium of the University of California. Remaining duplicates will be distributed to other botanical institutions.

[1] Additions to our knowledge of the Philippine Flora. I, Philip. Journ. Sci. 26 (1925) 447–496; II, 29 (1926) 475–496.

GRAMINEÆ

Genus **KOORDERSIOCHLOA** Merrill

Koordersiochloa javanica Merr.

Koordersiochloa javanica MERR. in Philip. Journ. Sci. 12 (1917) Bot. 67, *t. 1.*

LUZON, Benguet Subprovince, Mount Pulog, *Bur. Sci. 44923 Ramos and Edaño,* February, 1925, in the mossy forest, altitude about 2,400 meters.

A wholly unexpected addition to the list of Philippine genera; the genus is monotypic and hitherto was known only from the higher mountains of Java. One other monotypic genus of this family *Asthenochloa* (*Garnotiella*), has the same restricted distribution. Prof. A. S. Hitchcock has kindly compared the Philippine material with a part of the type collection of *Koordersiochloa javanica* Merr. in the United States National Herbarium and states that it is exactly the same as the Javan form.

LILIACEÆ

Genus **PLEOMELE** Salisbury

Pleomele bangueyensis Merr.

Pleomele bangueyensis MERR. in Philip. Journ. Sci. 29 (1926) 355.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44151, 44292 Ramos and Edaño,* August, 1924. BICAWAYAN, Calamian group, *Bur. Sci. 41294 Ramos,* all specimens in fruit.

The specimens cited all appear to be referable to the species recently described by me from Banguey Island, just off the northeastern coast of Borneo. In thickets and forests at low altitudes.

ZINGIBERACEÆ

Genus **AMOMUM** Linnæus

Amomum havilandii K. Schum.

Amomum havilandii K. SCHUM. in Engl. Bot. Jahrb. 27 (1899) 303.
Hornstedtia havilandii K. SCHUM. in Pflanzenreich 20 (1904) 193.

JOLO, Sulu Archipelago, *Bur. Sci. 44454 Ramos and Edaño,* September, 1924, in second-growth forests at low altitudes. Borneo.

The specimen closely matches *Elmer 20088* from British North Borneo which I originally identified as *Hornstedtia scyphifera* Steud., but which I now believe to represent K. Schumann's species.

Genus BOESENBERGIA O. Kuntze

Boesenbergia macropoda sp. nov.

Hebra erecta, glabra, circiter 60 cm alta, caulis 15 ad 18 cm longis; foliis 3 vel 4, membranaceis, oblongo-ellipticis, acuminatis, 20 ad 30 cm longis, 9 ad 11 cm latis, longissime (15 ad 20 cm) petiolatis; spicis paucifloris, in vaginis superioribus inclusis; floribus circiter 8 cm longis, corollae tubo tenue, ad 6.5 cm longo, lobis lanceolatis, acuminatis, membranaceis, 1.8 ad 2 cm longis, labellum circiter 2.5 cm longum et 1.5 ad 2 cm latum.

An erect glabrous herb about 60 cm high, the stems 15 to 18 cm long, entirely concealed by the imbricating sheaths, the lower sheath 3 to 4 cm long, the next about 7 cm long, the third about 15 cm long, lax, thin, all leafless. Leaves 3 or 4, greenish olivaceous, membranaceous, oblong-elliptic, sharply and shortly acuminate, 20 to 30 cm long, 9 to 11 cm wide, base more or less decurrent, midrib prominent, nerves slender, oblique; petioles 15 to 20 cm long. Spikes few-flowered, included in the upper sheath, a single flower opening at one time. Flowers red and pink, about 8 cm long, the calyx slender, the corolla tube slender, about 6.5 cm long, the lobes lanceolate, membranaceous, somewhat acuminate, 1.8 to 2 cm long, 3.5 to 4 mm wide. Labellum about 2.5 cm long and 1.5 to 2 cm wide. Anther oblong, about 7 mm in length.

JOLO, Sulu Archipelago, *Bur. Sci. 44394 Ramos and Edaño*, September, 1924, near cultivated areas at low altitudes, known to the Joloanos as *tamlang*.

The second species of the genus to be found in the Philippines, apparently allied to the Javan *Boesenbergia javana* (K. Schum.) Schltr. (*Gastrochilus javanum* K. Schum.) of Java. It is very different from the single species hitherto known from the Philippines (southwestern Mindanao), *B. longipetiolata* (Ridl.) Merr.

LORANTHACEÆ

Genus LORANTHUS Linnæus

Loranthus cordilimbus sp. nov. § *Dendrophthoë*.

Frutex parasiticus, inflorescentiis exceptis glaber, ramis ramulisque teretibus, ramulis circiter 3 mm diametro; foliis oppositis, coriaceis, subsessilibus, oblongo-ovatis ad ovato-lanceolatis, coriaceis, 8 ad 15 cm longis, 3 ad 8 cm latis, apice perspicue acuminatis, basi late rotundatis, distincte cordatis, nervis primariis

utrinque circiter obscuris, plerumque subobsoletis, petiolo crasso, 2 ad 4 mm longo; inflorescentiis terminalibus, circiter 10 cm longis, multifloris, floribus 6-meris, puberulis, 12 ad 15 mm longis, in triadibus racemose dispositis.

A parasitic shrub, glabrous except the inflorescences, the branches and branchlets terete, smooth, the latter about 3 mm in diameter. Leaves opposite, very shortly petiolate, coriaceous, rigid, oblong-ovate to ovate-lanceolate, 8 to 15 cm long, 3 to 8 cm wide, narrowed upward to the conspicuously and sharply acuminate apex, the base broad, abruptly rounded and distinctly cordate; lateral nerves slender, obscure, at most 7 on each side of the midrib, which is very prominent on the lower surface, often obsolete or nearly so; petioles stout, 2 to 4 mm long. Inflorescences terminal, about 10 cm long, many-flowered, somewhat furfuraceous, the flowers uniformly puberulent. Primary branches (triads) racemosely disposed, the branchlets 4 to 5 mm long, the bract of the sessile flower ovate to oblong-ovate, acuminate to acute, about 4 mm long, those of the pedicelled flowers somewhat smaller, the pedicels of the lateral flowers in each triad 3 to 3.5 mm long. Flowers (not quite mature) 6-merous, 12 to 15 mm long, puberulent, the calyx cylindric, 2.5 to 3 mm long, truncate, the corollas slightly inflated below, then narrowed, and expanding again at the tips (in bud), the anthers 2.5 mm long.

SAMAR, Loquilocon, *Bur. Sci. 43873 McGregor,* June, 1924, without notes, but probably from an altitude of about 250 meters, in forests.

Among the Philippine species perhaps as closely allied to *Loranthus saccatus* Elm. as any other species, but differing in its puberulent flowers and in its more prominently cordate, nearly sessile leaves.

ANONACEÆ

Genus **PSEUDUVARIA** Miquel

Pseuduvaria macgregorii sp. nov.

Arbor parva, circiter 3 m alta, dioica, ramulis pubescentibus; foliis chartaceis, oblongo-ovatis ad late oblongo-oblanceolatis, acuminatis, basi obtusis ad acutis, plerumque leviter inaequilateralibus, 15 ad 30 cm longis, 6 ad 12 cm latis, nervis primariis utrinque circiter 16, perspicuis; floribus ♂ axillaribus, plerumque in axillis defoliatis, fasciculatis, circiter 1 cm diametro, pedicellis circiter 1 cm longis; petalis exterioribus late ovatis, extus leviter pubescentibus, tenuiter nervosis, circiter 3 mm longis, obtusis, interioribus quam exterioribus crassioribus, sub-

rhomboideis, circiter 5 mm longis, subacutis, deorsum angustatis; staminibus 30 ad 35; fructibus obovoideis ad globosis, 1.5 ad 2 cm diametro, glabris vel subglabris, perspicue grosse irregulariter foveolatis; seminibus 2, plano-convexis, 10 ad 12 mm diametro.

A small diœcious tree, about 3 m high, the older branches nearly glabrous, the younger ones rather densely pubescent. Leaves chartaceous, olivaceous, oblong-ovate to broadly oblong-oblanceolate, 15 to 30 cm long, 6 to 12 cm wide, acuminate, base obtuse to acute, usually somewhat inequilateral, the upper surface glabrous or the midrib pubescent, the lower surface sparingly pubescent on the midrib and nerves; lateral nerves about 16 on each side of the midrib, conspicuous, obscurely arched-anastomosing, the reticulations slender; petioles stout, pubescent, 5 to 9 mm long. Flowers fascicled, axillary, and chiefly from the axils of fallen leaves, about 1 cm in diameter, their pedicels slender, somewhat pubescent, about 1 cm long, with a single broadly ovate bracteole about 1.5 mm long at the upper two-thirds. Sepals broadly ovate, acute, somewhat pubescent, 1.2 mm long. Outer petals flat, broadly ovate, slenderly 5- to 7-nerved, somewhat pubescent externally, obtuse, about 3 mm long; inner petals black when dry, much thicker than the outer ones, somewhat pubescent externally, subrhomboid, acute, the apical part often involute, narrowed below, but not clawed, about 5 mm long. Stamens 30 to 35, about 0.6 mm long, often wider than long. Pistillate flowers not seen. Fruits globose to obovoid, glabrous or nearly so, 1.5 to 2 cm in diameter, the pericarp irregularly longitudinally 7-keeled, or ridged, irregularly and coarsely foveolate, nearly black when dry; seeds two, plano-convex, 10 to 12 mm in diameter, the albumen ruminate.

SAMAR, Loquilocon, *Bur. Sci. 43714* (type), *43752 McGregor*, June, 1924, flowers pale yellow, altitude about 250 meters, apparently in primary forests.

A species distinguished from its Philippine congeners in this small genus by its larger, more numerously nerved leaves. The peculiarly ridged and coarsely and irregularly foveolate fruits are characteristic.

Genus **GONIOTHALAMUS** Hooker f. and Thomson

Goniothalamus suluensis sp. nov.

Arbor parva, circiter 7 m alta, floribus parce pubescentibus exceptis glabra ramulis teretibus, 2.5 ad 4 mm diametro; foliis magnis, chartaceis, late oblongis, 35 ad 48 cm longis, 11 ad 16

cm latis, in siccitate pallide olivaceis, nitidis, apice abrupte obtuseque acuminatis, basi late acutis, nervis primariis utrinque circiter 18, tenuibus; floribus axillaribus, solitariis, circiter 7 cm longis, sepalis ovatis ad oblongo-ovatis, acutis, circiter 1.5 cm longis, glabris vel subglabris; petalis exterioribus lanceolatis, tenuiter acuminatis, leviter pubescentibus, 7 cm longis, 1.5 cm latis, interioribus sepalis subaequantibus, oblongo-ovatis, acutis, extus plus minusve adpresse hirsutis; fructibus junioribus ellipsoideis ad subobovoideis, glabris, circiter 8 mm longis.

A small tree about 7 m high, nearly glabrous, the branches and branchlets terete, dark-colored when dry, the latter 2.5 to 4 mm in diameter. Leaves chartaceous, broadly oblong, pale olivaceous and shining when dry, 35 to 48 cm long, 11 to 16 cm wide, the apex abruptly and obtusely acuminate, the acumen stout, up to 1.5 cm long, base broadly acute; lateral nerves about 18 on each side of the midrib, slender, arched-anastomosing, the reticulations lax, not prominent; petioles stout, 1.5 to 2 cm long. Flowers axillary, solitary, about 7 cm long, the pedicels about 1.4 cm long, glabrous or nearly so. Sepals ovate to oblong-ovate, acute, about 1.5 cm long, glabrous or nearly so. Outer petals lanceolate, sparingly appressed-pubescent, slenderly acuminate, subcoriaceous, rather brittle when dry, 7 cm long, 1.5 cm wide. Inner petals about as long as the sepals, coriaceous, oblong-ovate, acute, outside more or less appressed-hirsute with ferruginous hairs, the margins densely pale-pubescent, glabrous or nearly so inside. Carpels numerous. Young fruits glabrous, ellipsoid to subobovoid, black when dry, about 8 mm long.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44350 Ramos and Edaño,* August, 1924, along Malum River near mangrove swamps. Locally known to the Joloanos as *nunang.*

A species in its very large leaves approaching *Goniothalamus gigantifolius* Merr., but with entirely different venation, much fewer, very much less conspicuous nerves, and entirely different fruits.

MYRISTICACEÆ

Genus **KNEMA** Loureiro

Knema insularis sp. nov.

Arbor circiter 1 m alta, ramulis tenuibus, dense breviter ferrugineo-pubescentibus; foliis anguste oblongis, firmiter chartaceis ad subcoriaceis, 14 ad 22 cm longis, 3 ad 6 cm latis, breviter acuminatis, basi late acutis ad subrotundatis, supra glaberrimis, nitidis, pallide olivaceo-viridibus, subtus glaucis, glabris vel

deorsum ad costa nervisque dense substellato-tomentosis; nervis lateralibus utrinque 20 ad 26, subtus perspicuis, petiolo 5 ad 10 mm longo; floribus ♂ axillaribus et in axillis defoliatis, circiter 9 mm diametro, extus dense ferrugineo-pubescentibus, intus glabris, pedicellis floribus subaequantibus; disco stamineo haud mamillato, circiter 3 mm diametro, antheris 18 ferentibus.

A tree about 7 m high, the branches terete, glabrous, rugose when dry, the branchlets slender, densely ferruginous-pubescent with short hairs. Leaves narrowly oblong, firmly chartaceous to subcoriaceous, 14 to 22 cm long, 3 to 6 cm wide, apex shortly acuminate, base broadly acute to somewhat rounded, the upper surface pale greenish olivaceous when dry, shining, glabrous, the lower surface glaucous, glabrous, or the midrib in the lower part and the lower nerves more or less densely pubescent with short ferruginous hairs; lateral nerves 20 to 26 on each side of the midrib, prominent, curved-anastomosing, the primary reticulations slender, subparallel; petioles densely ferruginous-pubescent, becoming glabrous, 5 to 10 mm long. Staminate flowers axillary and in the axils of fallen leaves, fascicled on short stout tubercles, red, brown when dry, about 9 mm in diameter, their ferruginous-pubescent pedicels not longer than the flowers. Perianth segments broadly ovate, rounded, about 4.5 mm long, pubescent externally, glabrous within. Staminal disk not umbonate, about 3 mm in diameter, bearing on its margin about 18 anthers, the latter about 0.5 mm in length.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44288 Ramos and Edaño,* July, 1924, in damp forests at low altitudes.

A species characterized by its relatively large staminate flowers and manifestly closely allied to the Bornean *Knema korthalsii* Warb., differing in its smaller leaves and its more-numerous anthers.

ROSACEÆ

Genus PYGEUM Gaertner

Pygeum subglabrum sp. nov.

Arbor parva, circiter 3 m alta, subglabra, ramis ramulisque glabris vel ramulis junioribus parcissime pubescentibus; foliis crasse coriaceis, rigidis, ellipticis, late acutis vel obscure brevissime acuminatis, basi late acutis ad subrotundatis, subtus biglandulosis, junioribus parcissime pubescentibus, vetustioribus glaberrimis, 6 ad 8 cm longis, 3.5 ad 5 cm. latis, nervis primariis utrinque circiter 7, perspicuis, petiolo crasso, 8 ad 14 mm longo; inflorescentiis lateralibus, e axillis defoliatis, plus

minusve ferrugineo-pubescentibus, ut videtur paucifloris, sub fructu circiter 3 cm longis; fructibus globosis, circiter 2 cm diametro, glabris, seminibus glabris.

A small tree about 3 m high, nearly glabrous, the branches and branchlets dark-colored when dry, glabrous or the very young branchlets slightly pubescent. Leaves thickly coriaceous, rigid, elliptic, 6 to 8 cm long, 3.5 to 5 cm wide, olivaceous when dry, the lower surface somewhat brownish, apex broadly acute or obscurely and shortly acuminate, base broadly acute to somewhat rounded, usually biglandular beneath, sometimes with but a single gland or glandless, the glands plane or somewhat impressed, although scarcely projecting on the upper surface, the younger leaves very sparingly pubescent, the mature ones entirely glabrous; lateral nerves 7 on each side of the midrib, prominent, the reticulations lax, rather indistinct; petioles glabrous, thick, 8 to 14 mm long. Inflorescences from the branches below the leaves, few, apparently few-flowered, more or less ferruginous-pubescent, in fruit about 3 cm long. Fruit (not mature) red when fresh, nearly black when dry, globose, glabrous, about 2 cm in diameter, the stout pedicels 3 to 4 mm long, glabrous inside as are the immature seeds.

LUZON, Benguet Subprovince, Mount Pulog, *Bur. Sci. 45014 Ramos and Edaño,* February 27, 1925, in the mossy forest at an altitude of about 2,700 meters.

A species well characterized by its thickly coriaceous, rigid, comparatively small leaves, its unusually large fruits, short infructescences, and in being nearly glabrous throughout except for the scattered hairs on the young parts and on the inflorescence. It is probably most closely allied to *Pygeum monticolum* Merr.

LEGUMINOSÆ

Genus **BAPHIA** de Candolle

Baphia borneensis Oliver.

> *Baphia borneensis* OLIVER in Hook. Ic. IV 5 (1896) *t. 2456;* LESTER-GARLAND in Journ. Linn. Soc. Bot. 45 (1921) 239.

TAWITAWI, Sulu Archipelgo, *Bur. Sci. 43964, 44153 Ramos and Edaño,* August, 1924, in forests at low altitudes.

The genus is new to the Philippines, the species common in northern Borneo. Of the fifty-eight known species of the genus one occurs in Madagascar, the one here enumerated in Borneo and the Sulu Archipelago, and all the others are confined to Africa and mainly to the tropical parts of that continent.

Genus **FORDIA** Hemsley

Fordia brachybotrys sp. nov.

Arbor parva, inflorescentiis leviter pubescentibus exceptis glabra, ramulis teretibus, 3 ad 4 mm diametro; foliis 30 ad 45 cm longis, 5-foliolatis, foliolis chartaceis, oblongis ad ellipticis vel oblongo-obovatis, 12 ad 24 cm longis, 6 ad 12 cm latis, basi acutis ad rotundatis, apice abrupte acuminatis, acuminis usque ad 2 cm longis, obtusis, nervis lateralibus 7 ad 9, tenuibus, distinctis, petiolulis 8 ad 10 mm longis; racemis solitariis vel fasciculatis, 6 ad 8 cm longis, caulinis vel e ramis vetustioribus, leviter pubescentibus, multifloris; floribus albido-purpureis, circiter 1.4 cm longis; leguminis oblique oblanceolatis, usque ad 16 cm longis, sursum usque ad 3.5 cm latis, deorsum angustatis, apice rostratis, valvis glabris, sublignosis vel crassissime coriaceis; seminibus 2 vel 3, compressis, circiter 1.2 cm diametro.

A small tree, glabrous except the sparingly pubescent cauline racemes. Branchlets slender, terete, glabrous, 3 to 4 mm in diameter. Leaves 30 to 45 cm long, 5-foliolate, the leaflets chartaceous, subolivaceous, somewhat paler beneath, shining on both surfaces, oblong to elliptic or oblong-obovate, 12 to 24 cm long, 6 to 12 cm wide, base acute to rounded, apex abruptly acuminate, the acumen up to 2 cm long, obtuse; lateral nerves 7 to 9 on each side of the midrib, slender, distinct, curved-anastomosing; petiolules 8 to 10 mm long, not stipellate. Racemes solitary or fascicled on the trunks and larger branches, sparingly appressed-pubescent, 6 to 8 mm long, many-flowered. Flowers purplish white, about 1.4 cm long, their pedicels 2.5 to 5 mm long. Calyx cup-shaped, truncate, about 5 mm long, bibracteolate at the base, the bracteoles elliptic, obtuse, about 1 mm long. Exposed parts of the petals appressed-pubescent with short hairs, the standard suborbicular-ovate, retuse, base truncate, about 12 mm in diameter, the claw 2 mm long or less; wings with 3 mm long claws, the limbs oblong, obtuse, about 11 mm long, 3.5 to 4 mm wide; keel petals similar to the wings. Ovary narrow, appressed-pubescent. Pod obliquely oblanceolate, up to 16 cm long, and 3.5 cm wide, flat, the valves almost woody, at least very thickly coriaceous, gradually narrowed from near the apex to the cuneate base, brown when dry, the apex oblique and with a conspicuous stout, more or less curved beak from the inner (seed-bearing) suture. Seeds 2 or 3, in the upper broader one-third of the pod only, compressed, almost circular in outline, about 12 mm in diameter.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44277 Ramos and Edaño,* July, 1924, in damp forests at low altitudes.

The first representative of the genus *Fordia* to be found in the Philippines, although it is very doubtful whether the group should be retained as of generic rank distinct from *Millettia;* practically the only constant distinguishing character appears to be the cauline inflorescences in *Fordia* as contrasted to the axillary ones of *Millettia.* The genus *Fordia* as at present constituted is represented by perhaps eight known species, extending from southeastern China to the Malay Peninsula, Sumatra, and Borneo. The present species is strongly characterized by its unusually broad leaflets.

Genus **MILLETTIA** Wight and Arnott

Millettia tenuipes sp. nov.

Frutex subglaber, ramis ramulisque teretibus, laevis, in siccitate brunneis, vix lenticellatis; foliis 5- vel 7-foliolatis, circiter 30 cm longis, glaberrimis, foliolis chartaceis vel submembranaceis, in siccitate subolivaceo-viridibus, nitidis, oblongo-ovatis ad oblongis, breviter acuminatis, basi plerumque rotundatis, 9 ad 14 cm longis, 3 ad 5 cm latis, nervis primariis utrinque circiter 7, tenuibus, distinctis, petiolulis circiter 7 mm longis, in siccitate nigris, estipellatis, racemis axillaribus, 12 ad 25 cm longis, pedunculatis, floribus circiter 2.5 cm longis, longissime (3 ad 4 cm) tenuiter pedicellatis, roseo-purpureis, calycis late cupulatis, parcissime adpresse pubescentibus, petalis extus in partibus superioribus plus minusve ferrugineo-pubescentibus, ovario leviter ciliato-hirsuto, sursum glabrescens.

An erect, nearly glabrous shrub, the branches and branchlets terete, slender, smooth, scarcely lenticellate, dark brown when dry, the very young parts sometimes with a few scattered hairs. Leaves about 30 cm long, the leaflets 5 or 7, oblong-ovate to oblong, 9 to 14 cm long, 3 to 5 cm wide, shortly acuminate, base rounded, entirely glabrous, subolivaceous greenish when dry, shining; lateral nerves about 7 on each side of the midrib, slender, distinct, arched, scarcely anastomosing or if so then very close to the margin; stipels none; petiolules black when dry, about 7 mm long. Racemes axillary, slender, 12 to 25 cm long, flower-bearing mostly in the upper one-half, the flowers comparatively few, not more than 25 to a raceme, about 2.5 cm long, pinkish purple, their slender pedicels 3 to 4 cm long. Calyx broadly cup-shaped, subtruncate, castaneous when dry, sparingly pubescent externally with short appressed hairs, the

margins more densely pubescent. Petals in bud (exposed portions) rather densely appressed subferruginous-pubescent, in anthesis the indumentum more or less scattered and largely confined to the upper parts. Staminal sheath glabrous. Ovary more or less ciliate hirsute below, glabrous or nearly so above.

LUZON, Zambales Province, Mount Marayep, *Bur. Sci. 44803 Ramos and Edaño,* December 12, 1924, along forested streams at low altitudes.

A species remarkable for its unsually large flowers and their slender, greatly elongated pedicels which attain a length of 4 cm. The species is apparently a very ornamental one and one well worthy of cultivation. It differs from all the hitherto described Philippine forms especially in its long pedicels and large flowers.

Genus **INTSIA** Thouars

Intsia retusa (Kurz) O. Kuntze.

Intsia retusa (Kurz) O. KUNTZE, Rev. Gen. Pl. (1891) 192.

Afzelia retusa KURZ in Journ. As. Soc. Bengal 42[2] (1873) 73; Prain ex KING, Journ. As. Soc. Bengal 66[2] (1897) 207; RIDL., Fl. Mal. Penin. 1 (1922) 639.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44348 Ramos and Edaño,* August, 1924, along Malum River in tidal swamps. In similar habitats from the Gangetic delta to Singapore and Borneo.

The specimens are in fruit and conform very closely with the descriptions except that the pods, described as 5 to 6 inches long and 2 inches wide, are 7 inches long and vary from 2 to 2.5 inches in width.

RUTACEÆ

Genus **MEROPE** M. Roemer

Merope angulata (Willd.) Swingle.

Merope angulata (Willd.) SWINGLE in Journ. Wash. Acad. Sci. 5 (1915) 423.

Citrus angulata WILLD., Sp. Pl. 3 (1800) 1426.

Sclerostylus spinosa BLUME, Bijdr. (1825) 134.

Atalantia longispina KURZ in Journ. As. Soc. Bengal 41[2] (1872) 295.

Gonocitrus angulatus KURZ, Journ. As. Soc. Bengal 42[2] (1847) 228, *t. 18.*

Paramignya angulata KURZ, Journ. As. Soc. Bengal 43[2] (1874) 135; VALETON in Ic. Bogor. 4 (1912) 159, *t. 348.*

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44341 Ramos and Edaño,* July, 1924. In mangrove forests, local name *balimbing-balimbingan.*

A monotypic genus new to the Philippines. For additional synonyms see Swingle [2] and Merrill.[3] India, through Malaysia to the Moluccas.

Genus GLYCOSMIS Correa

Glycosmis elmeri sp. nov.

Frutex circiter 1 m altus, partibus junioribus inflorescentiisque parcissime pubescentibus exceptis glaber, ramulis viridibus; foliis 3- vel 4-foliolatis 30 ad 40 cm longis, foliolis glaberrimis vel junioribus subtus parcissime pubescentibus, oblongo-ellipticis, chartaceis, in siccitate pallidis, nitidis, apice acuminatis, basi late acutis, 15 ad 30 cm longis, 7 ad 13 cm latis, nervis primariis utrinque 9 ad 11, distantibus, arcuato-anastomosantibus, subtus valde perspicuis; inflorescentiis terminalibus, pedunculatis, paniculatis, circiter 6 cm longis, ramis primariis paucis, patulis, 2 ad 3 cm longis; floribus 5-meris, glabris.

A shrub about 1 m high, entirely glabrous except for the obscure, rufous or castaneous, scattered hairs on the youngest parts and inflorescences, the branches smooth, terete, pale, shining, the branchlets greenish. Leaves 3- or 4-foliolate, 30 to 40 cm long, chartaceous, shining when dry, the upper surface pale olivaceous, the lower much paler than the upper, oblong-elliptic, 15 to 30 cm long, 7 to 13 cm wide, apex acuminate, the acumen usually blunt, the base broadly acute; lateral nerves 9 to 11 on each side of the midrib, distant, usually somewhat impressed on the upper surface, very prominent beneath, arched-anastomosing, the reticulations lax; petiolules about 5 mm long, the petioles and rachis 10 to 14 cm long, greenish. Inflorescences terminal, peduncled, paniculate, rather few-flowered, about 6 cm long, the peduncles as long as the flower-bearing parts, the primary branches few, spreading, 2 to 3 cm long, obscurely pubescent, some parts entirely glabrous. Flowers white, 5-merous, sessile, the sepals coriaceous, elliptic, rounded, about 1.2 mm long, their margins thin, slightly pubescent. Petals about 3 mm long, glabrous. Stamens 10. Ovary and style glabrous.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44150 Ramos and Edaño*, August 5, 1924, along small streams in damp forests at low altitudes.

[2] Journ. Wash. Acad. Sci. 5 (1915) 423.
[3] Interp. Rumph. Herb. Amb. (1917) 294.

A species characterized by its very large, pale, conspicuously nerved leaflets, apparently most closely allied to *Glycosmis platyphylla* Merr., from which it differs in its larger, more numerously nerved leaflets and shorter inflorescences. The same species is represented by *Elmer 20186, 20442* from British North Borneo.

DICHAPETALACEÆ

Genus **DICHAPETALUM** Thouars

Dichapetalum platyphyllum sp. nov.

Frutex ut videtur erectus, circiter 1 m altus, subglaber, ramis glabris, ramulis leviter pubescentibus; foliis ellipticis ad oblongo-ellipticis, chartaceis, in siccitate nitidis, supra subolivaceis, glaberrimis, subtus pallidioribus secus costa nervisque leviter adpresse pubescentibus glabrescentibus, apice breviter acuminatis, basi cuneatis vel acutis, 17 ad 22 cm longis, 7 ad 12 cm latis, nervis primariis utrinque 7 ad 9, curvato-adscendentibus, distantibus, perspicuis; inflorescentiis cymosis, axillaribus, ut videtur paucifloris, 2 ad 3 cm longis, leviter adpresse pubescentibus, sepalis persistentibus, ellipticis ad oblongo-ellipticis, circiter 3 mm longis; fructibus obovoideis, 2- vel 3-locellatis, 10 ad 12 mm longis, dense ferrugineo-pubescentibus.

Apparently an erect shrub about 1 m high, the branches glabrous, somewhat yellowish brown when dry, the branchlets sparingly appressed-pubescent. Leaves chartaceous, elliptic to oblong-elliptic, 17 to 22 cm long, 7 to 12 cm wide, shining, the upper surface subolivaceous, glabrous throughout, the lower surface paler and with few to rather many, pale, short, appressed hairs along the midrib and lateral nerves, ultimately becoming glabrous, the apex shortly acuminate, base cuneate to acute, sometimes somewhat decurrent acuminate; lateral nerves 7 to 9 on each side of the midrib, prominent, distant, curved-ascending, anastomosing rather close to the margins, the reticulations slender, distinct; petioles 1 to 1.5 cm long, slightly pubescent, rugose. Cymes axillary, apparently few-flowered, 2 to 3 cm long, more or less appressed pubescent with short subferruginous hairs. Flowers unknown, but the persistent sepals oblong to elliptic, rounded, somewhat pubescent, about 3 mm long. Fruits obovoid, when nearly mature about 12 mm long, densely ferruginous-pubescent with short hairs, 2- or 3-celled, the apex often somewhat retuse, the pericarp 2 to 3 mm thick.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44045 Ramos and Edaño,* July, 1924, in damp forests at low altitudes.

A species well characterized by its relatively large and broad leaves, and in being glabrous or nearly so, except for the inflorescences, the slightly pubescent branchlets, and the rather peculiar appressed hairs along the midrib and lateral nerves on the lower surface of the younger leaves.

EUPHORBIACEÆ

Genus MALLOTUS Loureiro

Mallotus moritzianus Muell.-Arg.

Mallotus moritzianus MUELL.-ARG. in DC. Prodr. 15^2 (1866) 971; PAX and HOFFM. in Pflanzenreich **63** (1914) 152.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44325 Ramos and Edaño*, August, 1924, in damp forests at low altitudes.

The specimens have larger leaves than does the typical Javan form, the largest ones being 30 cm long and 20 cm wide. They are distinctly caudate-acuminate, with shorter petioles, and are less conspicuously glandular than the type, while the venation approaches the pinnate type of *Hancea* and *Axenfeldia* rather more closely than it does the palmate or 3-nerved type of *Echinocroton*. Additional material may show that it is desirable to separate the Philippine form from the Javan one. Java and Borneo.

Genus PHYLLANTHUS Linnæus

Phyllanthus lancilimbus sp. nov.

Frutex glaber, dioicus, ramis teretibus, 3 ad 4 mm diametro, ramulis numerosis, confertis, usque ad 20 cm longis, tenuibus, circiter 1 mm diametro, angulatis vel anguste alatis; foliis numerosis lanceolatis, pallidis, subfalcatis, utrinque subaequaliter angustatis, chartaceis, utrinque acuminatis, 3 ad 6 cm longis, 4 ad 8 mm latis, nervis primariis utrinque 8 ad 10, tenuibus, patulis, indistinctis, arcuato-anastomosantibus; floribus ♂ axillaribus, fasciculatis, pedicellis usque ad 5 mm longis, perianthi segmentis 6, oblongis, obtusis, 2 mm longis; staminibus 3, filamentis liberis, ad 1 mm longis, antheris continuis, oblongis, 0.5 mm longis, extrorse longitudinaliter dehiscentibus.

A glabrous diœcious shrub, the branches terete, reddish brown to pale brown, 3 to 4 mm in diameter, bearing numerous, somewhat crowded ultimate branchlets, these slender, 10 to 20 cm long, about 1 mm in diameter, pale when dry, angled or narrowly winged, although toward the base often subterete, the branchlets subtended by several ovate to lanceolate, rather rigid, acuminate stipulelike bracts up to 4 mm in length. Leaves

numerous, pale, chartaceous, lanceolate, subfalcate, subequally narrowed to the cuneate base and the acuminate apex, the acumen often obtuse; lateral nerves slender, not prominent, spreading, 8 to 10 on each side of the midrib, arched-anastomosing, reticulations relatively lax, obscure; petioles 1 to 2 mm long; stipules about 1 mm long, suborbicular, inequilateral, often slightly concave, rounded, about 1 mm long. Staminate flowers numerous, axillary, fascicled, their pedicels up to 5 mm long. Perianth segments 6, subequal, oblong, obtuse, 2 mm long, apparently pale green. Stamens 3, their filaments free, rather stout, up to 1 mm long, the anthers continuous, oblong, extrorse, longitudinally dehiscent. Disk glands reniform-orbicular, about 0.2 mm long.

SAMAR, Loquilocon, *Bur. Sci. 43876 McGregor,* June, 1924, without notes except as to altitude which is indicated as about 250 meters.

The branchlets simulate pinnate leaves, as in many other species of this perplexing genus. The species is apparently remote from any of the hitherto described Philippine forms, being well characterized by its numerous, pale, lanceolate, slightly falcate, obscurely nerved leaves.

Phyllanthus caudatifolius sp. nov.

Frutex vel arbor parva, dioica, glabra, ramis teretibus, pallidis, ramulis tenuibus, elongatis, usque ad 35 cm longis, teretibus, 1 ad 1.5 mm diametro; foliis paucis, lanceolatis, chartaceis ad submembranaceis, 7 ad 14 cm longis, 1 ad 2.5 cm latis, basi acutis, apice tenuiter caudato-acuminatis, in siccitate supra olivaceis vel brunneo-olivaceis, subtus pallidis, nervis primariis utrinque circiter 5, curvato-adscendentibus, tenuibus, anastomosantibus, reticulis laxis; floribus ♂ axillaribus, fasciculatis, pedicellis usque ad 1 cm longis, perianthi segmentis 5, ellipticis, obtusis, 2 ad 2.5 mm longis, exterioribus angustioribus; staminibus 5, filamentis liberis, 1 ad 1.2 mm longis, antheris ovatis, introrsis, longitudinaliter dehiscentibus, disco circiter 1 mm diametro.

A shrub or small tree, diœcious, entirely glabrous, the branches terete, pale brownish, 3 to 5 mm in diameter, the branchlets slender, terete, 1 to 1.5 mm in diameter, pale, up to 35 cm long. Leaves scattered, lanceolate, chartaceous to submembranaceous, 7 to 17 cm long, 1 to 2.5 cm wide, base acute, apex slenderly caudate-acuminate, upper surface olivaceous to dark brown when dry, lower surface pale; lateral nerves about 5 on each

side of the midrib, curved-ascending, slender, arched-anastomosing, the reticulations lax; petioles about 2 mm long; stipules caducous. Staminate flowers axillary, fascicled, pale yellow, 5-merous, their pedicels up to 1 cm long. Perianth segments elliptic-oblong, rounded, 2 to 2.5 mm long, the outer two narrower than the inner three. Stamens 5, their filaments free, 1 to 1.2 mm long, the anthers ovate, introrse, longitudinally dehiscing, the disk about 1 mm in diameter.

SAMAR, Loquilocon, *Bur. Sci. 43867 McGregor,* June, 1924.

Another species remote from any hitherto described Philippine forms, its vegetative characters suggestive of a narrow-leaved form of *Securinega flexuosa* Muell.-Arg.; the presence of a disk, however, indicates *Phyllanthus.* The lanceolate, caudate-acuminate, few-nerved, relatively large leaves are characteristic.

Genus **SAPIUM** P. Browne

Sapium discolor (Champ.) Muell.-Arg.

Sapium discolor (Champ.) MUELL.-ARG. in Linnaea 32 (1863) 121; PAX in Pflanzenreich 52 (1912) 239.

Stillingia discolor Champ. ex BENTH. in Hook. Kew Journ. Bot. 6 (1854) 1.

Excoecaria discolor MUELL.-ARG. in DC. Prodr. 15^2 (1866) 1210.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44473 Ramos and Edaño,* August, 1924, in forests along streams at low altitudes. Southeastern China to Hainan, Indo-China, and the Malay Peninsula.

This is rather an unexpected addition to our list of Philippine species, the specimens representing the typical Chinese form.

Genus **CLEIDION** Blume

Cleidion microcarpum sp. nov.

Frutex erectus, glaber, ramis ramulisque tenuibus, ramulis viridibus, ramis pallidis; foliis chartaceis, oblongis ad oblongo-ellipticis, in siccitate pallide viridibus, nitidis, 6 ad 11 cm longis, 2.5 ad 4 cm latis, utrinque subaequaliter angustatis, apice distincte sed obtuse acuminatis apiculatisque, basi obtusis vel subacutis, margine leviter undulatis, inter undulis glanduloso-denticulatis, nervis primariis utrinque 6 vel 7, tenuibus, distinctis, petiolo tenuibe, 1 ad 2 cm longo; inflorescentiis ♂ axillaribus, spicatis, multifloris, 3 ad 7 cm longis, ♀ paucifloris, floribus longe pedicellatis, fructibus leviter pubescentibus, plerumque 3-coccis, circiter 7 mm diametro..

A diœcious glabrous shrub 1 m high or more, the branches and branchlets slender, terete, the former pale, the latter greenish when dry, the very young parts sometimes slightly pubescent. Leaves chartaceous, pale greenish when dry, shining, oblong to oblong-elliptic, 6 to 11 cm long, 2.5 to 4 cm wide, subequally narrowed to the acute or obtuse base and to the acuminate apex, the acumen blunt and apiculate, the margins subundulate and glandular-denticulate between the undulations, lateral nerves 6 or 7 on each side of the midrib, slender, distinct, curved, arched-anastomosing, the reticulations lax; petioles slender, 1 to 2 cm long. Inflorescences axillary, solitary, the staminate ones spicate, slender, many-flowered, 3 to 7 cm long, the flowers fascicled at the nodes, sessile or subsessile, the bracteoles minute, scarcely 0.5 mm long. Sepals 3, broadly ovate subacute, 2 mm long. Stamens about 50, their filaments less than 1 mm long. Pistillate racemes 6 to 13 cm long, slender, each bearing a very few, long-pedicelled flowers, the pedicels 1.5 to 3 cm long, thickened in the upper part. Sepals 3, triangular-ovate, acute, 1 mm long. Ovary more or less appressed pubescent; style arms slender, 5 mm long. Capsule subglobose, normally of three cocci, when young slightly appressed-pubescent, ultimately glabrous, about 7 mm in diameter. Seeds subglobose, smooth, 5 mm in diameter.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44226 Ramos and Edaño,* August, 1924, near the border of mangrove swamps.

A species manifestly belonging in the group with *Cleidion lanceolatum* Merr. of Samar and Bohol, but with differently shaped, much broader leaves. In vegetative characters it approaches small-leaved forms of the common and widely distributed *Cleidion spiciflorum* (Burm. f.) Merr. (*C. javanicum* Blume), but in floral and fruit characters it closely approximates *Cleidion lanceolatum* Merr.

Genus **CROTON** Linnæus

Croton zambalense sp. nov.

Arbor circiter 6 m alta, ramis glabris, lenticellatis, partibus junioribus pallide stellato-pubescentibus; foliis submembranaceis, in siccitate utrinque viridibus, verruculosis, ad costa nervisque stellato-pubescentibus, subellipticis, 7 ad 12 cm longis, 3.5 ad 5.5 cm latis, obtusis, basi 2-glandulosis, late acutis ad rotundatis, 5-plinerviis, margine obscure irregulariter distanter crenato-serratis vel subundulatis, sinubus subtus cum glandulis

sessilibus intra-marginalibus ornatis, nervis utrinque 5 vel 6, adscendentibus, distinctis; inflorescentiis 9 ad 16 cm longis, leviter stellato-pubescentibus; floribus ♂ numerosis, plerumque 5-meris, 5 ad 6 mm diametro, sepalis extus leviter stellato-pubescentibus, petalis ad basin apiceque villosis, staminibus circiter 15. Floribus ♀ paucis, ovario dense subflavido-stellato-hirsuto; fructibus junioribus obovoideis, circiter 12 mm diametro.

A monœcious tree about 6 m high, the branches glabrous, dark-colored when dry, lenticellate, somewhat rugose, the branchlets rather densely stellate-pubescent with pale short stiff hairs. Leaves submembranaceous, green and of about the same color on both surfaces when dry, distinctly verruculose, subelliptic, 7 to 12 cm long, 3.5 to 5.5 cm wide, sparingly stellate-pubescent on the midrib and nerves on both surfaces, ultimately nearly glabrous, the apex obtuse, base broadly acute to rounded, 5-plinerved, and with a pair of sessile, conspicuous, pale, hard, shining glands on the lower surface, these with a central depression, margins distantly, obscurely, and irregularly crenate-serrate or subundulate, the sinuses on the lower surface with sessile glands similar to the basal pair but somewhat smaller; lateral nerves, including the basal ones, 5 or 6 on each side of the midrib, ascending, distinct; petioles 1 to 2.5 cm long, stellate-pubescent. Inflorescences terminal, rather slender, 9 to 16 cm long, more or less stellate-pubescent with pale stiff hairs. Staminate flowers numerous in the upper part, serially falling from the basal part upward, 5 to 6 mm in diameter, their pedicels about 3 mm long, mostly 5-merous. Sepals ovate to oblong-ovate, obtuse, thin, sparingly stellate-pubescent, 2.5 to 3 mm long. Petals oblong, 3 mm long, base and apex densely villous. Stamens about 15, their filaments glabrous, 2 mm long. Pistillate flowers few, near the base of the inflorescence, their sepals lanceolate, somewhat acuminate, 3 mm long, the pedicels stout, very densely stellate-hirsute with pale yellowish hairs. Ovary very densely stellate-hirsute; style bases about 2 mm long, more or less stellate-pubescent, the arms glabrous. Young fruits obovoid, about 12 mm in diameter, densely stellate-hirsute with pale yellowish hairs.

LUZON, Zambales Province, Mount Tapulao, *Bur. Sci. 44709 Ramos and Edaño,* November, 1924, on forested slopes, altitude about 900 meters.

Probably as closely allied to *Croton colubrinoides* Merr. as any other species, differing in its verruculose leaves, its indumentum, its sessile basal glands, and in other characters.

ANACARDIACEÆ

Genus **SEMECARPUS** Linnæus f.

Semecarpus stenophylla sp. nov.

Frutex vel arbor parva, inflorescentiis leviter pubescentibus exceptis glaber, ramis teretibus, ramulis circiter 2 mm diametro; foliis numerosis, confertis, anguste lanceolatis ad lineari-lanceolatis, rectis vel leviter falcatis, coriaceis, rigidis, usque ad 20 cm longis et 12 mm latis, utrinque subaequaliter angustatis, supra olivaceis, subtus pallidis; nervis lateralibus numerosis (usque ad 40 utrinque), patulis, arcuato-anastomosantibus, secundariis inter primariis transversis, ab illis angulo recto abuentes; paniculis circiter 10 cm longis, partibus junioribus plus minusve pubescentibus, sepalis triangulari-ovatis, acutis, 1 mm longis; drupa oblique ovata, glabra, subcastanea, 9 mm longa, hypocarpio carnoso, rubro.

A shrub or small tree, glabrous except the slightly pubescent inflorescences. Leaves numerous, crowded, narrowly lanceolate to linear-lanceolate, straight or slightly falcate, rigid, coriaceous, gradually and subequally narrowed at both ends, long acuminate, the tips obtuse, margins sometimes obscurely undulate, 12 to 20 cm long, 6 to 12 mm wide, upper surface olivaceous, lower pale, somewhat glaucous; lateral nerves numerous, straight, distinct, spreading, arched-anastomosing, up to 40 or more on each side of the midrib, the secondary nerves leaving the primary ones at right angles; petioles stout, 5 to 15 mm long. Panicles terminal, apparently few-flowered, about 10 cm long, the younger parts somewhat pubescent, the branches few, 2 to 3.5 cm long. Sepals triangular-ovate, acute, about 1 mm long. Mature fruits dark brown, obliquely ovoid, about 9 mm long, glabrous, the younger ones sparingly pubescent, the fleshy pedicels red when fresh, apparently larger than the drupes, when dry as long as the latter but narrower.

SAMAR, Loquilocon, *Bur. Sci. 43866 McGregor,* July, 1924.

A species very strongly characterized by its numerous, elongated, very narrow leaves, in this character differing radically from all hitherto described species of the genus. No notes, other than brief ones appertaining to the fruits, accom-

pany the specimens, but the material available rather clearly indicates that this stenophyllous *Semecarpus*, like many of the other stenophyllous Malaysian plants, grows along the margins of small streams in places subject to sudden and brief overflows.

ICACINACEÆ

Genus IODES Blume

Iodes ovalis Blume.

Iodes ovalis BLUME, Bijdr. (1825) 30; KING in Journ. As. Soc. Bengal 64 [2] (1895) 128; RIDL., Fl. Mal. Penin. 1 (1922) 435.

JOLO, Sulu Archipelago, *Bur. Sci. 44435 Ramos and Edaño*. Along small streams in forests at low altitudes; rare.

The specimen has mature and immature fruits which are ovoid and somewhat compressed, very different from the oblong ones of *Iodes philippinensis* Merr., and the leaves are much larger. Whether or not this is the form that Blume actually described may be subject to some doubt, but in any case the specimens appear to be referable to the form described under this name by King and by Ridley; they, however, reduce *Iodes tomentella* Miq. to *Iodes ovalis* Blume, whereas the Dutch botanists, Koorders and others, retain the latter two as distinct. The Jolo form seems clearly to represent *Iodes ovalis* Blume as figured and described by Bennett in Plantae Javanicae Rariores (1852) 243, *t. 48*.

RHAMNACEÆ

Genus ZIZYPHUS Tournefort

Zizyphus suluensis sp. nov.

Frutex scandens, ramis glabris, teretibus, lenticellatis, spinis solitariis recurvatis armatis, ramulis tenuibus, pubescentibus; foliis subcoriaceis, oblongis ad oblongo-ellipticis, 4 ad 7 cm longis, perspicue sed obtuse acuminatis, basi leviter inaequilateralibus, obtusis ad rotundatis, 3-nerviis, nervis secondariis lateralibus carentibus, margine minutissime glanduloso-denticulatis, junioribus ad nervis leviter pubescentibus, vetustioribus glabris; cymis axillaribus, parvis, paucifloris, breviter pedunculatis, 1 ad 1.5 cm longis, circiter 1.2 cm diametro, pubescentibus; floribus viridibus, circiter 5 mm diametro, extus pubescentibus, intus glabris, petalis cucullatis obovatis, inflexis, 1.5 mm longis.

A scandent shrub, the branchlets, petioles, inflorescences, and the younger leaves more or less pubescent with short, dark brown hairs. Branches terete, dark brown, lenticellate, glabrous, the branchlets slender, about 1 mm in diameter, the stipular spines

solitary, rather stout, recurved, 1.5 to 3 mm long. Leaves subcoriaceous, rather pale when dry, the older ones entirely glabrous, the younger ones sparingly pubescent along the nerves on both surfaces, oblong to oblong-elliptic, 4 to 7 cm long, 1.5 to 2.6 cm wide, base slightly inequilateral, obtuse to rounded, apex conspicuously blunt-acuminate, margins minutely glandular-denticulate; longitudinal nerves 3, impressed above, prominent beneath, the lateral pair extending into the acumen, lateral ones from the side nerves wanting, the reticulations fine, close; petioles slender, 3 to 5 mm long. Cymes axillary, small, few-flowered, more or less pubescent, 1 to 1.5 cm in diameter, their peduncles 1 cm long or less, the pedicels 2 to 3 mm long, the bracteoles oblong, obtuse, 1.5 mm long. Flowers greenish, about 5 mm in diameter, pubescent externally, glabrous within, the calyx lobes broadly triangular-ovate, acute or acuminate, 2 mm long. Petals obovate, cucullate, inflexed, 1.5 mm long. Filaments glabrous, 1.2 mm long. Disk 3 mm in diameter.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44295 Ramos and Edaño*, August, 1924, in damp forests along small streams at low altitudes.

A species well characterized by the entire absence of lateral nerves between the longitudinal pair and the leaf margins, except for the fine and rather close reticulations. Its alliance is manifestly with *Zizyphus elegans* Wall., for which the name *Z. subquinquenervia* Miq. should probably be accepted; the latter species, however, has prominent nerves between the longitudinal pair and the leaf margins. It is to be noted that King[4] describes the cymes of *Zyzyphus elegans* Wall. as having stalks as long as the leaves; doubtless "petioles" was intended, as Ridley describes the cymes as 0.6 inch long, which conforms with Miquel's description of *Zizyphus subquinquenervia* Miq., which King states is a synonym of Wallich's species. Except in leaf size the characters of *Zizyphus ornata* Miq., ex descr., apply closely to the present species.

STERCULIACEÆ

Genus STERCULIA Linnæus

Sterculia longisepala sp. nov.

Frutex circiter 2 m altus, ramulis et petiolis et inflorescentiis perspicue patule ciliato-hirsutis, ramulis 4 ad 5 mm diametro; foliis late oblongo-oblanceolatis, chartaceis, 15 ad 30 cm longis,

[4] Journ. As. Soc. Bengal 65 [2] (1896) 374.

6 ad 11 cm latis, integris, perspicue tenuiter acuminatis, basi obtusis ad rotundato-cordatis, subtus plus minusve ciliato-hirsutis, nervis primariis utrinque circiter 12, perspicuis; petiolo 2 ad 7 cm longo; stipulis setaceis, ciliato-hirsutis, 1.5 ad 2 cm longis; paniculis terminalibus, angustis, plus minusve flexuosis, 15 ad 45 cm longis, 5 ad 7 cm latis, multifloris; floribus circiter 3 cm longis, calycis segmentis lineari-lanceolatis, 2.5 cm longis, deorsum circiter 3 mm latis, arcuatis, juvenilis leviter cohaerentibus, cito liberis.

A shrub about 2 m high, conspicuously ciliate-hirsute with rather stiff spreading, more or less ferruginous hairs. Branchlets 4 to 5 mm in diameter, the older parts glabrous, the younger parts conspicuously ciliate-hirsute as are the petioles, the long spreading hairs being intermixed with a short, denser indumentum. Leaves somewhat crowded near the tips of the branchlets, chartaceous, broadly oblanceolate, entire, 15 to 30 cm long, 6 to 11 cm wide, apex conspicuously acuminate, narrowed below, the base obtuse to rounded-cordate, the upper surface glabrous except for the ferruginous-pubescent and ciliate-hirsute midrib, the lower surface somewhat paler, ciliate-hirsute on the midrib, nerves and larger reticulations, and with shorter scattered stellate hairs on the reticulations; petioles 2 to 7 cm long; stipules setaceous, ciliate-hirsute, numerous, crowded near the apices of the branchlets, dark brown, 1.5 to 2 cm long. Panicles narrow, somewhat flexuous, 15 to 45 cm long, 5 to 7 cm wide, many-flowered, all parts conspicuously ferruginous ciliate-hirsute with spreading hairs which are intermixed with a shorter denser indumentum. Flowers reddish or brownish red, about 3 cm long, ciliate-hirsute, the tubular part about 6 mm long, slightly enlarged upward, base cuneate, the lobes 5, linear-lanceolate, arched, slightly cohering when young, soon free, about 2.5 cm long, 3 mm wide below, their margins revolute, gradually narrowed upward to the somewhat acuminate tip. Staminal column about 2 mm long, the anther mass depressed-globose, about 1.2 mm in diameter, the stamens 10, about 0.5 mm long. Pistillate flowers similar to the staminate ones, the ovary ovoid-globose, densely pubescent, 2 mm in diameter; style ciliate, 1.5 mm long, sharply bent to one side.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44070* (type), *44157 Ramos and Edaño*, July, 1924, in damp forests near small streams at low altitudes.

A species strongly characterized by its narrow setaceous stipules and its conspicuously ciliate-hirsute branchlets, stipules, petioles, and inflorescences, as well as by its elongated, narrow, more or less flexuous inflorescences, and its linear-lanceolate, elongated perianth lobes which when young are slightly coherent by their tips but soon free.

DIPTEROCARPACEÆ

Genus VATICA Linnæus

Vatica papuana Dyer.

Vatica papuana DYER in Journ. Bot. 16 (1878) 100; BRANDIS in Journ. Linn. Soc. Bot. 31 (1895) 127.

Vatica moluccana BURCK in Ann. Jard. Bot. Buitenz. 6 (1887) 226, *t. 26.*

Vatica schumanniana GILG in Engl. Bot. Jahrb. 18 (1894) Beibl. 45: 38.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44349 Ramos and Edaño,* August, 1924, in forests at low altitudes.

This species has not hitherto been recorded from the Philippines; in fact, no representative of the section *Retinodendron* has before been found within the limits of the Archipelago, although other representatives of the section occur from Ceylon to New Guinea. The specimen is a very close match for *Ramos 1903* from Batu Lima, near Sandakan, British North Borneo, originally referred by me to *Vatica rassak* Blume, but which Dr. Van Slooten finds to be referable to Dyer's species. Borneo, Moluccas, and New Guinea.

FLACOURTIACEÆ

Genus FLACOURTIA L'Héritier

Flacourtia rukam Zoll. and Mor. var. **myriantha** var. nov.

A typo differt floribus ♂ numerosissimis, ad nodos densissime confertis, inflorescentiis 1.5 ad 2.5 cm diametro.

JOLO, Sulu Archipelago, *Bur. Sci. 43910 Ramos and Edaño,* September, 1924, along small streams in forests near the summit of Mount Daho, altitude about 700 meters.

In general the specimens come well within the range of variation of the widely distributed *Flacourtia rukam* Zoll. and Mor., differing in the very numerous crowded staminate flowers. In the lower inflorescences, especially those in the axils of fallen

leaves, there are several hundred flowers in each, while in the uppermost inflorescences there may be as few as twenty-five flowers.

Genus CASEARIA Jacquin

Casearia nitens sp. nov.

Frutex circiter 3 m altus, juvenilis exceptis glaber, ramulis elongatis plus minusve flexuosis, laevis, brunneis, glabris; foliis integerrimis, chartaceis, oblongis, perspicue acuminatis, basi subaequilateralibus, rotundatis, in siccitate brunneis vel olivaceobrunneis, subtus pallidioribus, utrinque nitidis, glaberrimis, 14 ad 20 cm longis, 5 ad 8 cm latis, nervis primariis utrinque 9 vel 10, perspicuis, reticulis tenuibus, distinctis, subparallelis, petiolis glabris, 12 ad 17 mm longis; floribus axillaribus, fasciculatis, paucis, glabris, circiter 3 mm longis; staminibus 10, staminoideis anguste oblongis, ciliatis; capsulis subellipsoideis, circiter 1 cm longis, apiculatis, laevis, haud carinatis vel sulcatis, seminibus paucis (circiter 4), ovoideis, arillus flavidus, leviter fimbriatus.

An almost entirely glabrous shrub about 3 m high, the tips of the young branchlets slightly pubescent. Ultimate branchlets greatly elongated, up to at least 60 cm long, somewhat zigzag-flexuous, smooth, brown, glabrous, the internodes 3 to 6 cm long. Leaves chartaceous, oblong, entirely glabrous, brown and shining on both surfaces when dry, paler beneath, 14 to 20 cm long, 5 to 8 cm wide, entire, the apex rather conspicuously acuminate, base subequilateral, rounded; lateral nerves 9 or 10 on each side of the midrib, prominent, curved, arched-anastomosing, the primary reticulations slender, distinct, rather close, subparallel; petioles glabrous, 12 to 17 mm long. Flowers yellow, in few-flowered, axillary fascicles, their pedicels glabrous, about 3 mm long. Sepals oblong-elliptic, rounded, entirely glabrous, 3 mm long. Stamens 10, the alternating ones slightly shorter than the others, the filaments slender, glabrous, 1.2 mm long, the alternating staminodes 10, narrowly oblong, ciliate, about as long as the stamens. Ovary narrowly ovoid, glabrous, the style about 1 mm long. Fruit yellow when fresh, castaneous when dry, shining, smooth, subellipsoid, apiculate, about 1 cm long, the pericarp not at all ridged or sulcate. Seeds few (about 4), ovoid, 4 mm long, the somewhat fleshy aril yellow, sparingly laciniate.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44116* (type), *44128 Ramos and Edaño,* August, 1924, in damp forested ravines at low altitudes.

The alliance of this species is apparently with *Casearia hosei* Merr. of Borneo, separated by its distinctly flexuous elongated branchlets and by being glabrous in all parts except the very youngest parts of the branchlets.

VIOLACEÆ

Genus **RINOREA** Aublet

Rinorea castilloi Merr.

Rinorea castilloi MERR. in Philip. Journ. Sci. 21 (1922) 530.

JOLO and TAWITAWI, Sulu Archipelago, *Bur. Sci. 44017, 44163, 44447 Ramos and Edaño,* in forests along small streams at low altitudes. British North Borneo and Banguey Island.

The specimens, all in fruit, match a fruiting specimen from Banguey Island, and the type, a flowering specimen from British North Borneo. Its true alliance seems to be with *Rinorea hirtella* (Ridl.) comb. nov. (*Alsodeia hirtella* Ridl.), of the Malay Penins[illegible]om which it is distinguished by its entirely glabrous leaves.

BEGONIACEÆ

Genus **BEGONIA** Linnæus

Begonia samarensis sp. nov. § *Petermannia.*

Suffruticosa, erecta, ramosa, circiter 2 m alta, ramis scabris, partibus junioribus adpresse ferrugineo-hirsutis; foliis subchartaceis, inaequilateraliter oblongis, 7 ad 11 cm longis, 2.5 ad 4 cm latis, basi lateraliter cordatis, margine denticulatis, sursum irregulariter dentato-lobatis, apice acuminatis, supra olivaceis, parce setulosis, subtus pallidioribus et ad costa nervisque ferrugineo-hirsutis; petiolo circiter 2 cm longo; inflorescentiis axillaribus, depauperato-cymosis, circiter 3 cm longis, parce ferrugineo-hirsutis; floribus ♂ paucis, sepalis 2, orbiculari-ovatis, rotundatis, circiter 8 mm diametro, extus parce setulosis; antheris circiter 25; capsulis 1 ad 1.5 cm longis, parce setulosis, aequaliter 3-alatis, apice truncatis, basi rotundatis.

An erect, suffrutescent, branched plant about 2 m high, the branches terete, hard, woody, about 4 mm in diameter, somewhat scabrous from the bases of the persistent hairs, the younger

parts more or less appressed ferruginous-hirsute. Leaves oblique, inequilateral, oblong, subchartaceous, 7 to 11 cm long, 2.5 to 4 cm wide, base laterally cordate, broader side rounded, narrower side subacute, apex acuminate, margins denticulate, and in the upper one-half or one-third irregularly dentate-lobed, the lobes few, acute, not exceeding 1 cm in length, the upper surface olivaceous, sparingly ferruginous-setulose, the lower surface paler and rather densely ferruginous-hirsute on the midrib and nerves, with scattered short stout hairs on the surface; petioles about 2 cm long; stipules lanceolate, deciduous, up to 1 cm long. Inflorescences axillary, depauperate-cymose, about 3 cm long, the branches few, slender, elongated, somewhat ferruginous-hirsute, and with rather numerous pairs of lanceolate, acuminate bracteoles 1.5 to 2 mm long. Staminate flowers few, the sepals 2, white, orbicular-ovate, about 8 mm in diameter, slightly setulose outside. Stamens about 25. Capsules solitary at the base of the staminate inflorescence, 1 to 1.5 cm long, and 1 cm wide, equally 3-winged, truncate at the apex, base rounded, sparingly setulose.

SAMAR, Loquilocon, *Bur. Sci. 43757 McGregor*, July, 1924, in hillside forests, altitude about 250 meters.

This was first referred to *Begonia jagori* Warb., which is very different in habit, with much shorter petioles and scarcely cordate leaves.

COMBRETACEÆ

Genus TERMINALIA Linnæus

Terminalia plagata sp. nov.

Arbor circiter 6 m alta, ramis glabris, circiter 7 mm crassis, ramulis cicatricibus multis instructis, 5 mm diametro, partibus junioribus adpresse ferrugineo-pubescentibus; foliis numerosis, in ramulis ultimis confertis, coriaceis ad subcoriaceis, oblongo-obovatis, supra minute punctatis, apice rotundatis, basi cuneatis, eglandulosis vel obscure biglandulosis, 6 ad 11 cm longis, 2.5 ad 6 cm latis, supra glabris, nitidis, subtus pallidioribus, leviter pubescentibus glabrescentibus, axillis domatiis perspicuis instructis, nervis utrinque circiter 10; spicis pubescentibus, circiter 10 cm longis; fructibus subellipsoideis, 2 ad 2.5 cm longis, circiter 1.5 cm crassis, glabris, laevis, rostrato-apiculatus, obscure compressis, haud carinatis, pericarpio circiter 5 mm crasso.

A tree about 6 m high, the branches glabrous, about 7 mm thick, reddish brown and grayish, the branchlets about 5 mm thick, marked with numerous scars of fallen leaves, the younger

parts appressed-pubescent with short ferruginous hairs. Leaves crowded near the tips of the branchlets, numerous, subcoriaceous, oblong-obovate, apex rounded, narrowed below to the cuneate base, 6 to 11 cm long, 2.5 to 6 cm wide, the younger ones more or less pubescent, the mature ones glabrous and shining on the upper surface, minutely puncticulate, greenish olivaceous, the lower surface paler, slightly pubescent, the base with or without a pair of glands, these when present obscure, the axils of the primary nerves with very conspicuous pits (domatia) sometimes nearly 1 mm in diameter; lateral nerves about 10 on each side of the midrib, slender, distinct, the reticulations fine; petioles ferruginous-pubescent, 6 to 11 mm long. Spikes about 10 cm long, more or less pubescent. Fruit red when mature, subellipsoid, 2 to 2.5 cm long, about 1.5 cm thick, obscurely compressed, not at all keeled, glabrous, smooth, shining, the apex somewhat rostrate-apiculate, the pericarp about 5 mm thick.

BILATAN ISLAND, immediately south of Tawitawi, Sulu Archipelago, *Bur. Sci. 44338 Ramos and Edaño,* July 31, 1924, in forests near the seashore.

Allied to *Terminalia pellucida* Presl, but with much smaller fruits. The large and conspicuous domatia are characteristic. It differs from *Terminalia edulis* Blanco in its differently shaped leaves and larger, scarcely compressed fruits.

MYRTACEÆ

Genus **XANTHOMYRTUS** Diels

Xanthomyrtus diplycosifolia (C. B. Rob.) comb. nov.

Eugenia diplycosifolia C. B. ROB. in Philip. Journ. Sci. 4 (1909) Bot. 347; MERR., Enum. Philip. Fl. Pl. 3 (1923) 165.

In addition to the specimens cited by me, we now have:

LUZON, Benguet Subprovince, Mount Pulog, *Bur. Sci. 44976 Ramos and Edaño,* February, 1925.

Xanthomyrtus aurea (Elm.) comb. nov.

Eugenia aurea ELM., Leafl. Philip. Bot. 4 (1912) 1400; MERR., Enum. Philip. Fl. Pl. 3 (1923) 158.

In addition to the specimens cited by me, we now have: MINDANAO, Davao Province, Mount Apo, *Mrs. Clemens.*

Diels [5] has with good reasons segregated from *Myrtus* certain Malaysian and Papuasian species, including one from New Caledonia, and probably one from northeastern Australia, some

[5] Engl. Bot. Jahrb. 57 (1922) 362–367.

originally placed in *Myrtus*, others in *Eugenia*. The two Philippine species enumerated above, originally placed in *Eugenia*, appertain to *Xanthomyrtus*. In addition to the species placed here by Diels two Bornean species belong in *Xanthomyrtus;* namely, *Myrtus moultonii* Merr. and *Myrtus taxifolia* Ridl. *Xanthomyrtus* as at present constituted is represented by two species in the Philippines, three in Borneo, thirteen in New Guinea, one in New Caledonia, and apparently one in northeastern Australia (*Myrtus metrosideros* Bailey).

Genus EUGENIA Micheli

Eugenia suluensis sp. nov. § *Jambosa.*

Arbor parva, glaberrima, ramis ramulisque rubro-brunneis, laevis, ramulis 2.5 ad 3 mm diametro, distincte 4-angulatis, junioribus interdum anguste 4-alatis; foliis oppositis, oblongis ad oblongo-ellipticis, coriaceis, olivaceis vel olivaceo-brunneis, nitidis, 15 ad 25 cm longis, 6 ad 9 cm latis, utrinque subaequaliter angustatis, apice acuminatis, basi acutis, vix punctatis; nervis primariis utrinque circiter 15, subtus valde perspicuis; inflorescentiis axillaribus terminalibusque, brevibus, paucifloris, calycis tubo circiter 1 cm longo, 8 mm diametro, lobis perspicue glandulosis.

A small glabrous tree, the branches and branchlets brownish red, smooth, the branchlets distinctly 4-angled and the younger ones often narrowly 4-winged, 2.5 to 3 mm in diameter. Leaves opposite, oblong to oblong-elliptic, coriaceous, the upper surface olivaceous and shining when dry, the lower surface brownish, not glandular-punctate, 15 to 25 cm long, 6 to 9 cm wide, the apex rather conspicuously acuminate, base acute; lateral nerves about 15 on each side of the midrib, very prominent on the lower surface, spreading, slightly curved, anastomosing directly with the equally distinct and scarcely arched marginal nerves 5 to 8 mm from the margin of the leaf, the alternating secondary nerves slightly more prominent than the rather lax reticulations; petioles stout, 5 to 7 mm long. Inflorescences axillary and terminal, few-flowered, the peduncle and axis at most 2.5 cm long, sometimes greatly reduced, the flowers then almost fascicled, rarely solitary, the bracts obscure, a single pair. Flowers white, the buds obovoid, distinctly stalked, the stalk thickening more or less after anthesis, the calyx about 1 cm long, including the stalklike part, and at most 8 mm in diameter, the lobes suborbicular-rounded, about 6 mm in diameter, prominently pitted

with conspicuous scattered glands. Stamens numerous, up to 10 mm long.

JOLO, Sulu Archipelago, *Bur. Sci. 43916 Ramos and Edaño,* September, 1924, in forests along small streams near the summit of Mount Daho, altitude about 700 meters.

A species probably as closely allied to *Eugenia hutchinsonii* Merr. as any other described form, but with very different leaves, and much fewer lateral nerves.

Eugenia montalbanica nom. nov.

Eugenia diospyrifolia MERR. in Philip. Journ. Sci. 27 (1925) 39, non Wall.

A new name is needed for the species based on *Loher 13307, 13328,* and *14879* from Montalban, Rizal Province, Luzon. The specific name *diospyrifolia* is preoccupied, a fact overlooked by me in describing this Philippine form.

MELASTOMATACEÆ

Genus **ANPLECTRUM** A. Gray

Anplectrum suluense sp. nov.

Frutex scandens, ramis teretibus, glabris, ramulis perspicue stellato-pubescentibus; foliis chartaceis, in siccitate viridibus, fragilis, supra glabris, nitidis, subtus parce stellato-pubescentibus, oblongis, 9 ad 14 cm longis, 3 ad 5 cm latis, basi late rotundatis, plerumque distincte cordatis, 5-nerviis, apice tenuiter acuminatis; petiolo 5 mm longo, stellato-pubescente, sursum parce setoso; inflorescentiis terminalibus, usque ad 30 cm longis, stellato-pubescentibus, ramis divaricatis; floribus 4-meris, calycis cylindrico-urceolatis, truncatis, 6 ad 7 mm longis, parce stellato-pubescentibus, haud setosis; petalis oblongo-ovatis, 6 ad 7 mm longis; staminibus 8, dimorphis, minoribus imperfectis, majoribus antheris curvatis, circiter 8 mm longis, connectivo basi antice bilamellato, postice 1-lamellato.

A scandent shrub, the branches terete, glabrous, the branchlets slender, more or less ferruginous-stellate-pubescent, the indumentum distinctly deciduous. Leaves oblong, chartaceous, green when dry, the upper surface glabrous, shining, the lower surface with scattered stellate ferruginous hairs, the nerves densely ferruginous-pubescent, 9 to 14 cm long, 3 to 5 cm wide, base broadly rounded, 5-nerved, distinctly cordate, apex slenderly acuminate, the inner, stouter pair of nerves reaching nearly to the apex; petioles about 5 mm long, densely stellate-pubescent

with ferruginous hairs, setose along the upper side, especially near the base of the leaf. Panicles terminal, up to 30 cm long, the lower branches subtended by somewhat reduced leaves, all parts more or less stellate-pubescent, the indumentum pale to ferruginous. Flowers 4-merous, numerous. Calyx sparingly stellate-pubescent, cylindric-urceolate, truncate, 6 to 7 mm long, 3 to 3.5 mm in diameter. Petals white, oblong-ovate, acute to obtuse, glabrous, 6 to 7 mm long, about 3.5 mm wide. Stamens 8, dimorphous, the alternate, smaller ones infertile. Fertile stamens with filaments about 5 mm long, the anthers lanceolate, strongly curved, about 8 mm long, connectives not produced, supplied on the inner side with two membranaceous, ovate appendages about 0.5 mm long, and on the back with a single similar appendage 1 mm in length. Sterile anthers at most 4 mm in length, the anterior and dorsal appendages oblong, 1.5 mm long, similar in size and shape.

JOLO, Sulu Archipelago, *Bur. Sci. 44461 Ramos and Edaño*, along small streams in forests at low altitudes, rare.

The alliance of this species is manifestly with *Anplectrum divaricatum* (Willd.) Triana, of the Malay Peninsula, Sumatra, Java, and Borneo, but it has larger leaves, very different connective appendages, especially the dorsal one, and the calyces are not at all setose. The first representative of the genus to be found within the limits of the Philippine Archipelago, *Anplectrum divaricatum* (Willd.) Triana having been erroneously credited to the group by Fernandez-Villar.

UMBELLIFERÆ

Genus **PEUCEDANUM** Tournefort

Peucedanum japonicum Thunb.

Peucedanum japonicum THUNB., Fl. Jap. (1784) 117.

SABTAN, Batan Islands, *Merrill 11755*, May, 1923, in crevices of cliffs along the seashore.

The genus is new to the Philippine flora, the species, as currently interpreted, extending from Japan to Formosa. Thunberg's species is erroneously reduced in Index Kewensis to *Ligusticum acutifolium*, an error for *L. acutilobum* S. and Z. Dr. O. Juel, of Upsala, to whom a fragment of the Philippine plant was sent, states that it is very similar to Thunberg's type, the latter having pubescent pedicels and slightly pubescent fruits, whereas the Sabtan plant is glabrous. Dr. B. Hayata states that

the specimen cited above is identical with the Formosan form referred to *Peucedanum japonicum* Thunb., which he is inclined to consider as specifically distinct from the Japanese form, it having more rounded leaf lobes. I suspect that the record of *Ligusticum acutilobum* S. and Z. as Formosan was based on the erroneous reduction of Thunberg's species, and that the form so recorded from Formosa is really the present species.

ERICACEÆ

Genus **RHODODENDRON** Linnæus

Rhododendron taxifolium sp. nov.

Frutex epiphyticus circiter 1 m altus, ramis glabris, ramulis glabris vel obscurissime puberulis, parce lepidotis, teretibus, 1 ad 1.5 mm diametro, internodiis 1 ad 3 cm longis; foliis numerosissimis ad nodis pseudoverticillatim-confertis, coriaceis, rigidis, viridibus, linearis, 2 ad 3.5 cm longis, 1 ad 1.5 mm latis, obtusis, sessilibus vel subsessilibus, subtus parce lepidotis; floribus terminalibus, solitariis vel paucis, subcampanulatis, albidis, circiter 2 cm longis, extus parce lepidotis, lobis late obovatis, rotundatis, 1 cm longis.

An epiphytic shrub about 1 m high. Branches terete, glabrous, ultimate branchlets slender, 1 to 1.5 mm in diameter, glabrous or very obscurely puberulent, the younger ones sparingly lepidote; internodes 1 to 3 cm long. Leaves numerous, crowded in pseudoverticels at the nodes, often twenty or more in a pseudoverticel, green, linear, sessile or subsessile, obtuse, 2 to 3.5 cm long, 1 to 1.5 mm wide, rigid, coriaceous, shining, beneath (at least when young) sparingly lepidote, ultimately glabrous, the margins very obscurely crenulate. Flowers subcampanulate, white, terminal, solitary or few, about 2 cm long, their pedicels pubescent, somewhat lepidote, about 1 cm long. Calyx 3 to 4 mm in diameter, lepidote and pubescent. Corolla tube about 1 cm long, 6 mm in diameter, sparingly lepidote outside, pubescent within, the lobes broadly obovate, rounded, 1 cm long. Stamens 10, subequal, the filaments 10 to 11 mm long, pubescent below, glabrous above; anthers oblong, obtuse, 2.5 mm long. Ovary oblong, pubescent, 3 mm long; style about 6 mm long, pubescent in the lower one-half, glabrous above.

LUZON, Benguet Subprovince, Mount Pulog, *Bur. Sci. 44880 Ramos and Edaño* (type), *Mrs. Clemens 15763*, February, 1925, on trees in the mossy forest, altitude about 2,700 meters.

A most remarkable species strongly characterized by its numerous, pseudoverticillate, *Taxus*-like leaves, whence its specific name.

MYRSINACEÆ

Genus **DISCOCALYX** Mez

Discocalyx suluensis sp. nov.

Frutex glaber, circiter 1 m altus, ramulis ultimis crassis, rugosis, 5 ad 8 mm diametro; foliis ad apices ramulorum plus minusve confertis, chartaceis vel subcoriaceis, integerrimis, oblanceolatis ad oblongo-oblanceolatis, sessilibus vel brevissime crasseque petiolatis, 30 ad 40 cm longis, 6 ad 9 cm latis, apice acutis, deorsum angustatis, basi acutis vel obtusis, utrinque glanduloso-puncticulatis, nitidis, olivaceo-viridibus, nervis primariis utrinque circiter 20, perspicuis, irregularis, arcuato-anastomosantibus, reticulis laxis; inflorescentiis lateralibus, in ramulis specialibus crassis claviformis, circiter 2 cm longis dispositis; paniculis angustis, 4 ad 5 cm longis; floribus 5-meris, calycis lobis rotundatis, brevibus, glanduloso-punctatis.

A glabrous shrub, about 1 m high, apparently unbranched, the ultimate branches (or upper part of the main stem) terete, rugose, 5 to 8 mm in diameter. Leaves more or less crowded, chartaceous to subcoriaceous, entire, oblanceolate to oblong-oblanceolate, 30 to 40 cm long, 6 to 9 cm wide, apex acute, narrowed below to the acute or slightly obtuse base, subsessile or with a very short stout petiole, both surfaces greenish olivaceous and shining when dry, glandular-punctate; lateral nerves about 20 on each side of the midrib, distant, irregular, arched-anastomosing, prominent, the reticulations lax; petioles very short or wanting, up to 5 mm wide. Panicles few, narrow, 4 to 5 cm long, borne at or near the tips of special leafless lateral branches, these branches spreading at right angles, club-shaped, about 2 cm long, 3 mm in diameter below and somewhat thickened upward, the upper part with scars of fallen bracts and peduncles. Young fruits 5 to 6 mm in diameter, crowned by the sessile stigma, the calyces thin, 2.5 to 3 mm in diameter, with five very short, broadly rounded lobes, conspicuously glandular-punctate with reddish or yellowish glands.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44293 Ramos and Edaño*, July, 1924, in damp forests at low altitudes.

A species characterized by its entire, elongated, oblanceolate leaves and its short, lateral, club-shaped special branches bearing the narrow inflorescences. The lateral branches of the panicles, in fruit, do not exceed 5 mm in length.

EBENACEÆ

Genus DIOSPYROS Linnæus

Diospyros elliptifolia sp. nov.

Arbor parva, glabra (floribus ignotis), ramulis ultimis tenuibus, in siccitate nigris, laevis, circiter 1.5 mm diametro; foliis coriaceis, ellipticis, in siccitate supra subolivaceis vel pallidis, subtus pallidioribus, laevis, 10 ad 20 cm longis, 6 ad 11 cm latis, apice breviter obtuseque acuminatis, basi, late acutis ad subrotundatis; nervis lateralibus supra subobsoletis, subtus tenuibus, distinctis, circiter 7 utrinque, distantibus, arcuato-anastomosantibus, reticulis laxis, subobsoletis, petiolis crassis, circiter 3 mm longis; fructibus axillaribus, solitariis, sessilibus, subglobosis, in siccitate laevis, nitidis, atris, circiter 2 cm diametro, calycis lobis accrescentibus, coriaceis, oblongo-ovatis, acutis, 1 ad 1.3 cm longis.

A small glabrous tree (flowers unknown), the branches and branchlets terete, the latter black when dry, smooth, slender, about 1.5 mm in diameter. Leaves coriaceous, in texture tough when dry, scarcely brittle, elliptic, 10 to 20 cm long, 6 to 11 cm wide, the apex rather abruptly, shortly, and broadly blunt-acuminate, base broadly acute to rounded, olivaceous or pale and shining on the upper surface when dry, the lower surface paler, dull; lateral nerves subobsolete on the upper surface, beneath slender, distinct, distant, arched-anastomosing, about 7 on each side of the midrib, the reticulations lax, subobsolete; petioles about 3 mm long. Fruits axillary, solitary, sessile, globose, about 2 cm in diameter, smooth, black, and shining when dry, the pericarp when dry thin, brittle. Calyx lobes accrescent, coriaceous, oblong-ovate, acute, 1 to 1.3 cm long, with somewhat radiating faint nerves, the central portion sometimes slightly longitudinally sulcate.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44020 Ramos and Edaño,* in damp forests along small streams at low altitudes; rare.

A species well characterized by its accrescent, ovate to oblong-ovate, glabrous, coriaceous, acute, nearly plane calyx lobes; its globose, black, shining fruits; and its elliptic, shortly petioled, distantly nerved, coriaceous leaves, the reticulations lax and subobsolete.

Diospyros suluensis sp. nov.

Arbor circiter 10 m alta, partibus junioribus plus minusve pubescentibus, ramulis elongatis, ultimis usque ad 60 cm longis, teretibus; foliis oblongo-lanceolatis, chartaceis, acute acuminatis, basi plerumque rotundatis, circiter 20 cm longis, 5 ad 7 cm latis, utrinque glabris vel subtus ad costa puberulis, supra olivaceis, laevis, nitidis, subtus brunneis, nervis primariis utrinque circiter 15, tenuibus, distinctis, arcuato-anastomosantibus, reticulis tenuibus, distinctis; inflorescentiis brevibus, racemosis, in ramis vetustioribus, racemis paucifloris, pubescentibus, ut videtur circiter 2 cm longis; fructibus ovoideo-ellipsoideis, laevis, glabris, 3.5 ad 4 cm longis, circiter 3 cm diametro, calycibus accrescentibus, lignosis, circiter 3.5 cm diametro, 5-lobatis, lobis triangulari-ovatis, acutis.

A tree about 10 m high, the younger parts more or less pubescent. Branches terete, glabrous, the branchlets elongated, up to 60 cm long, older parts glabrous, younger parts slightly pubescent, the upper portions 1.5 to 2 mm in diameter. Leaves chartaceous, oblong-lanceolate, slenderly and sharply acuminate, base mostly rounded, about 20 cm long, 5 to 7 cm wide, the upper surface smooth, olivaceous, entirely glabrous, the midrib impressed, the lower surface paler, brownish, sparingly puberulent on the midrib; lateral nerves slender, distinct, arched-anastomosing, about 15 on each side of the midrib, the reticulations fine, rather close, distinct; petioles glabrous or slightly pubescent, about 5 mm long. Inflorescences racemose, from the axils of fallen leaves on branches about 1 cm thick, the racemes pubescent, apparently about 2 cm long (judging from fruiting specimens), few-flowered, the persistent pedicels 5 to 8 mm long, stout, the axis of the raceme forming a stout, 2 cm long pedicel for the solitary fruit. Fruit said to be red when mature, when apparently full grown but immature ovoid-ellipsoid, 3.5 to 4 cm long, about 3 cm in diameter, smooth, glabrous, the pericarp about 2 mm thick, apex rounded. Accrescent calyx woody, about 3.5 cm in diameter, with numerous rounded or ellipsoid lenticels, 5-lobed, the lobes broadly triangular-ovate, acute, 1.2

to 2 cm wide, about 1.5 cm long, the sinuses subacute and somewhat thickened.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44068 Ramos and Edaño,* August, 1924, in forests along small streams at low altitudes.

Perhaps as closely allied to *Diospyros pauciflorus* C. B. Rob. as any other described form, but with very different fruits.

APOCYNACEÆ

Genus KIBATALIA G. Don

Kibatalia puberula sp. nov.

Arbor parva, ramulis foliisque subtus puberulis; foliis subcoriaceis, ellipticis, brevissime (ca. 2 mm) petiolatis, basi rotundatis, plerumque leviter inaequilateralibus, apice breviter abrupte obtuseque acuminatis, 12 ad 16 cm longis, 5 ad 9 cm latis, nervis primariis utrinque 8 ad 10; floribus terminalibus, solitariis, albidis, circiter 7 cm longis, pedicellis 2.5 ad 3 cm longis, sepalis extus puberulis, late ovatis, obtusis, 3 ad 4 mm longis, corollae tubo 1.5 cm longo, lobis oblongo-oblanceolatis ad oblanceolatis, falcatis, obtusis, usque ad 6.5 cm longis, 8 ad 12 mm latis.

A small tree, the branchlets, pedicels, and lower surface of the leaves distinctly puberulent, the branches 3 to 4 mm in diameter, terete, glabrous. Leaves subcoriaceous, rather pale when dry, scarcely or but slightly shining, elliptic, 12 to 16 cm long, 5 to 9 cm wide, base rounded, usually somewhat inequilateral, apex very shortly and abruptly obtuse-acuminate; lateral nerves 8 to 10 on each side of the midrib, distinct; petioles stout, about 2 mm long. Flowers white, solitary, terminal, about 7 cm long, their pedicels puberulent, somewhat thickened upward, 2.5 to 3 cm long. Sepals broadly ovate, obtuse, externally puberulent, 3 to 4 mm long, the basal internal glands compressed, white, ovate to subreniform, about 1 mm in diameter. Corolla tube glabrous, about 1.5 cm long, the lobes oblong-oblanceolate to oblanceolate, falcate, obtuse, up to 6.5 cm long, 8 to 12 mm wide, narrowed below. Disk glands suborbicular, rounded-truncate, their margins ciliate, 1 to 1.5 mm in diameter. Anthers lanceolate, acuminate, 6 mm long, the connectives appressed-hirsute in the upper part. Carpels glabrous; styles 6 to 7 mm long.

SAMAR, Loquilocon, *Bur. Sci. 43767 McGregor,* July, 1924, a small tree overhanging streams at 250 meters altitude.

A species well characterized by its indumentum as well as by its very shortly petioled leaves. For the reasons why *Kibatalia* G. Don should be maintained in place of *Kickxia* Blume, see Merrill.[6]

VERBENACEÆ

Genus CLERODENDRON Linnæus

Clerodendron flavum sp. nov.

Frutex circiter 1 m altus, ramulis inflorescentiisque dense sordide pubescentibus; foliis membranaceis, subellipticis, integris, supra glabris, laevis, olivaceis, subtus ad costa nervisque puberulis, glandulis paucis disciformibus instructis, usque ad 30 cm longis et 16 cm latis, apice late acutis, basi rotundatis, nervis primariis utrinque circiter 9, perspicuis; petiolo 2 ad 6 cm longo; paniculis terminalibus, erectis, circiter 15 cm longis, dense multifloris, bracteis bracteolisque parvis; calycis 8 mm longis, puberulis, lobis 5, lanceolatis, acuminatis, 6 mm longis, glandulis paucis disciformibus instructis; corollae flavae, tubo glabro vel leviter puberulo, tenue, 16 mm longae, lobis oblongo-obovatis, rotundatis, 1 cm longis, filamentis glabris, exsertis, rubris.

An erect shrub about 1 m high, the branches terete, grayish, glabrous, the ultimate branchlets densely pubescent with dirty brown hairs. Leaves somewhat crowded near the tips of the branchlets, membranaceous, olivaceous, subelliptic or broadly elliptic, entire, apex broadly acute, base rounded, 15 to 30 cm long, 10 to 16 cm wide, the upper surface olivaceous, smooth, glabrous, the lower slightly paler, distinctly puberulent on the midrib, nerves, and reticulations, and with widely scattered, small, disklike glands; petioles rather densely pubescent, 2 to 6 cm long. Panicles terminal, erect, densely many-flowered, about 15 cm long and wide, rather densely pubescent with dirty brown hairs, the primary branches up to 8 cm long, spreading or somewhat ascending, the lower ones subtended by greatly reduced leaves not exceeding 1.5 cm in length, these sometimes wanting; bracts and bracteoles small, deciduous, the latter scarcely 1 mm in length. Flowers yellow. Calyx about 8 mm long, sparingly pubescent or puberulent, the lobes 5, lanceolate, acuminate, slenderly 3-nerved, about 6 mm long, 1.5 mm wide, outside supplied with scattered, small, often rather obscure, disklike glands. Corolla tube slender, 1.6 cm long, glabrous or slightly puberulent,

[6] Philip. Journ. Sci. 17 (1920) 306–310.

the lobes spreading, subequal, oblong-obovate, broadly rounded, about 1 cm long and 5 mm wide. Stamens glabrous, exserted about 2 cm, red when fresh.

JOLO, Sulu Archipelago, *Bur. Sci. 43899 Ramos and Edaño*, September, 1924, in forests along small streams near the summit of Mount Daho, altitude about 700 meters.

A species remarkable for its yellow flowers, manifestly belonging in the group with *Clerodendron williamsii* Elm., but differing in very numerous characters. It is clearly more closely allied to *Clerodendron myrmecophyllum* Ridl. of the Malay Peninsula and Borneo than it is to *C. williamsii* Elm. I do not agree with Bakhuizen [7] in his reduction of the two species mentioned above as varieties of the Javan *Clerodendron macrophyllum* Blume.

Genus **CALLICARPA** Linnæus

Callicarpa nigrescens sp. nov.

Frutex circiter 2 m altus, ramis teretibus, glabris vel subglabris, ramulis tenuibus, dense minuteque stellato-subfurfuraceis vel stellato-sublepidotis, foliis membranaceis vel subchartaceis, oblongis ad late oblongo-lanceolatis, usque ad 15 cm longis et 6 cm latis, tenuiter acuminatis, basi acutis ad decurrento-acuminatis, marginis crenatis vel crenato-dentatis, vetustioribus supra glaberrimis, nitidis, nigricantibus, subtus paullo pallidioribus, minute denseque foveolatis, glandulosis, parce stellato-pubescentibus praesertim ad costa nervisque; nervis lateralibus circiter 7 utrinque, curvato-adscendentibus, tenuibus, distinctis; cymis axillaribus, petiolo subaequantibus, dense multifloris; floribus 4-meris, calycis truncatis, dense stellato-pubescentibus, corolla glabra vel subglabra.

A shrub about 2 m high, the branches terete, older ones glabrous, the branchlets slender, densely and minutely stellate-furfuraceous or stellate-sublepidote, the indumentum brown or pale. Leaves opposite, membranaceous to subchartaceous, oblong to broadly oblong-lanceolate, 6 to 15 cm long, 3 to 6 cm wide, slenderly and sharply almost caudate-acuminate, base acute or decurrent-acuminate, margins crenate or crenate-dentate, the upper surface dark brown to black and shining when dry, entirely glabrous or with scattered stellate hairs when immature, the lower surface paler than the upper, minutely and rather densely pitted and with numerous shining glands, the indumentum of

[7] Bull. Jard. Bot. Buitenz. III 5 (1922) 82.

short, pale, stellate, scattered hairs, for the most part confined to the midrib and lateral nerves; lateral nerves about 7 on each side of the midrib, slender, curved-ascending, distinct; petioles 1 to 3 cm long, minutely and rather densely stellate-pubescent. Cymes axillary, mostly densely flowered, about as long as the petioles, the peduncle, branches, and calyces densely and minutely stellate-pubescent with pale or brownish hairs, the pedicels about 1.5 mm long, the bracteoles linear, 0.5 mm long. Calyx truncate, about 2 mm long, 1.5 mm in diameter, narrowed below to the cuneate base. Corolla tube 2 mm long, glabrous, the lobes 4, oblong-elliptic, rounded, glabrous or very slightly pubescent above, about 1.5 mm long. Filaments glabrous, 4 to 4.5 mm long; anthers oblong, 1.3 mm long. Style exserted, glabrous, 7 mm long. Fruit globose, glabrous, black when dry, about 2 mm in diameter.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44297* (type), *44198 Ramos and Edaño,* July and August, 1924, in secondary forests at low altitudes.

A species rather well characterized within the genus by its very short indumentum, which is dense on the branchlets and inflorescences, and wanting or very sparse on the vegetative parts. The leaves are characteristically black or dark colored on the upper surface when dry, as in *Callicarpa cana* Linn. and *C. bicolor* Juss., and the species is apparently allied to these in spite of the differences in indumentum. According to Bakhuizen's arrangement of the species, it would apparently fall near or with *Callicarpa japonica* Thunb. and *C. longifolia* Lam., to neither of which can it be properly referred. I doubt very much if any of the Philippine or Malaysian material is properly referable to Thunberg's species.

ACANTHACEÆ

Genus RUELLIA Plumier

Ruellia luzoniensis sp. nov.

Herba erecta, leviter ramosa, ramis plerumque viridibus, plus minusve cinereo-puberulis; foliis lanceolatis ad oblongo-lanceolatis, in siccitate fragilis, viridibus, utrinque cystolithis numerosis instructis, integris, acutis ad acuminatis, basi acutis, subchartaceis, 6 ad 13 cm longis, 2 ad 4 cm latis, petiolo 8 ad 18 mm longo; floribus axillaribus, solitariis, sessilibus, pallide caeruleis, circiter 7 cm longis, extus leviter pubescentibus, bracteis

oblanceolatis, foliaceis, 2 ad 3 cm longis; capsulis circiter 1.8 cm longis, pubescentibus.

An erect, sparingly branched herb 35 to 45 cm high, the stems 2 to 3 mm in diameter, usually dark-colored when dry, terete, the branches usually green or dark green, cinereous-puberulent, obscurely sulcate. Leaves of each pair equal, lanceolate to oblong-lanceolate, 6 to 13 cm long, 2 to 4 cm wide, green when dry, with numerous cystoliths on both surfaces, entire, acute or acuminate, base acute, the younger ones sparingly pubescent, older ones glabrous; lateral nerves 5 to 7 on each side of the midrib, slender; petioles 8 to 18 mm long. Flowers axillary, solitary, sessile, pale blue, about 7 cm long. Bracts oblanceolate, 2 to 3 cm long, 2.5 to 4 mm wide, foliaceous, sparingly pubescent, acuminate. Calyx more or less pubescent, the tube short, the lobes 5, equal, narrowly lanceolate, acuminate, 4 to 4.5 mm long. Corolla more or less pubescent externally with short, white, scattered hairs, the tube about 7 cm long, the lower 3 mm rather slender, cylindric, then amplified and 8 to 10 mm in diameter, the lobes broadly ovate, rounded, 1.5 to 2 cm long. Style filiform, at least 5 cm long, sparingly ciliate-hirsute throughout. Filaments glabrous, the anthers 2.5 mm long. Capsule about 1.8 cm long, cinereous-pubescent, about 7.5 mm in diameter in the thickened upper portion, thickly rostrate, narrowed below. Seeds few, glabrous.

LUZON, Zambales Province, Anuling, *Bur. Sci. 44627 Ramos and Edaño*, November, 1924, in forests along streams at low altitudes.

A species resembling luxuriant forms of *Ruellia repens* Linn., differing in its larger leaves and in its very much larger flowers, which attain a length of 7 cm.

Genus **PSEUDERANTHEMUM** Radlkofer

Pseuderanthemum confusum sp. nov.

Suffruticosa, erecta, vix ramosa, 25 ad 40 cm alta, glabra vel subglabra, caulis glabris, teretibus, 2 ad 3 mm diametro, partibus junioribus glabris vel leviter obscure pubescentibus; foliis membranaceis ad chartaceis, oblongo-ovatis ad elliptico-ovatis, glabris, supra plus minusve lineolatis, olivaceis, subtus pallidioribus, 6 ad 15 cm longis, 3.5 ad 6 cm latis utrinque subaequaliter angustatis, apice acuminatis, basi acutis ad decurrento-acuminatis, nervis primariis utrinque 7 ad 9, tenuibus, distinctis; petiolo 1 ad 2.5 cm longo; spicis terminalibus, erectis, multifloris,

6 ad 11 cm longis, glabris vel obscure pubescentibus; floribus albis, glabris, tubo 3 cm longo.

An erect, unbranched, nearly glabrous, suffrutescent plant 25 to 40 cm high, the stems terete, 2 to 3 mm in diameter, the younger parts sometimes obscurely pubescent. Leaves in equal pairs, membranaceous to chartaceous, oblong-ovate to elliptic-ovate, 6 to 15 cm long, 3.5 to 6 cm wide, subequally narrowed to the acuminate apex and to the acute or decurrent-acuminate base, the upper surface olivaceous, with more or less conspicuous, irregularly disposed cystoliths, the lower surface somewhat paler; lateral nerves slender, distinct, 7 to 9 on each side of the midrib; petioles 1 to 2.5 cm long. Spikes terminal, solitary, 6 to 11 cm long, glabrous or obscurely pubescent, the bracts lanceolate, 1 to 1.5 mm long, acuminate. Sepals lanceolate, about 1.5 mm long, glabrous or nearly so. Corolla white, the tube slender, glabrous, about 3 cm long, the lobes spreading, about 1 cm in length. Capsules glabrous, 2 cm long, the thickened seed-bearing portion about as long as the narrowed basal part. Seeds compressed, 4 mm in diameter.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44296 Ramos and Edaño* (type), August, 1924, in damp forests along small streams at low altitudes. The same species is also represented by *Castro and Melegrito 1611* from Banguey Island, a fruiting specimen, and by *Wood 445* from British North Borneo, previously reported by me as *Pseuderanthemum album* (Roxb.) Merr. Ridley [8] is authority for the statement that *Eranthemum album* as interpreted by King and Gamble is apparently *Pseuderanthemum graciliflorum* Ridl., certainly not *Eranthemum album* Nees. The present species is apparently allied to *Pseuderanthemum kingii* Ridl. of the Malay Peninsula and *P. diversifolium* (Miq.) Koord. of Java.

RUBIACEÆ

Genus IXORA Linnæus

Ixora grandifolia (Blume) Zoll. & Mor.

Ixora grandifolia (Blume) ZOLL. and MOR., Syst. Verzeich. Zoll. Pfl. (1854–1855) 65; KOORD. and VAL., Bijdr. Boomsoort Java 8 (1902) 150; KOORD., Atlas Baumart. Java 3 (1915) *f. 545*.
Pavetta macrophylla BLUME, Bijdr. (1826) 953.

TAWITAWI, Sulu Archipelago, *Bur. Sci. 44011 Ramos and Edaño*, August, 1924, in forests at low altitudes.

[8] Fl. Mal. Penin. 2 (1923) 592.

The specimens, although in fruit, apparently represent the typical form of this Malayan species, which is here credited to the Archipelago for the first time other than Fernandez-Villar's and Vidal's identifications of the very different *Ixora macrophylla* Bartl. with this species. Malay Peninsula, Sumatra, Java, and Borneo.

CUCURBITACEÆ

Genus **ZANONIA** Linnæus

Zanonia indica Linn.

Zanonia indica LINN., Sp. Pl. ed. 2 (1763) 1457; COGN. in DC. Monog. Phan. 3 (1881) 926; Pflanzenreich **69** (1916) 27.

Alsomitra simplicifolia MERR., in Philip. Journ. Sci. **20** (1922) 470; Enum. Philip. Pl. 3 (1923) 579.

Juppia borneensis MERR., in Journ. Straits Branch Roy. As. Soc. **85** (1922) 170.

MINDANAO, Zamboanga District, *Bur. Sci. 37397 Ramos and Edaño.* TAWITAWI, Sulu Archipelago, *Bur. Sci. 43947 Ramos and Edaño.* Along streams in forests. India and Ceylon through Malaysia to New Guinea and New Mecklenburg.

This is here recorded to verify the occurrence of this monotypic genus in the Philippines and to place the two synonyms listed. Fernandez-Villar's [9] record of it as Philippine was undoubtedly based on a representative of some other genus erroneously identified. *Juppia borneensis* Merr., described from Bornean material, has been correctly reduced to *Zanonia indica* Linn. by Harms [10] who has also [11] indicated that the type collection of *Alsomitra simplicifolia* Merr. is *Zanonia indica* Linn. with immature fruits.

COMPOSITÆ

Genus **WEDELIA** Jacquin

Wedelia stenophylla sp. nov.

Herba erecta vel scandens, ramis scaberulis, circiter 2 mm diametro, rigidis; foliis lineari-lanceolatis, distanter lobulatis, 2.5 ad 6 cm longis, usque ad 5 mm latis, asperis, subtus hirsutis; capitulis turbinatis, circiter 9 mm diametro, squamis oblongo-lanceolatis, obtusis ad acuminatis, 4 ad 5 mm longis, hispidis; acheniis immaturis, 2 mm longis, apice truncatis, pilosis.

[9] Novis. App. (1880) 98.

[10] Über die Gattung Juppia Merrill, Notizbl. Bot. Gart. Berlin **8** (1924) 717–719.

[11] Engl. Bot. Jahrb. **60** (1925) 154.

An erect or scandent herb, the branches rigid, terete, 2 mm in diameter, scaberulous. Leaves (in the upper part of the plant) linear-lanceolate, distantly and irregularly lobulate, the lobules oblong, obtuse, scarcely exceeding 2 mm in length, the upper surface hispid, asperous, the lower surface with pale hairs, 2.5 to 6 cm long, 2 to 5 mm wide. Heads mostly solitary, long peduncled, turbinate, about 9 mm in diameter, the outer involucral bracts pubescent, oblong-lanceolate, obtuse to acuminate, 4 to 5 mm long, hispid, the inner ones narrower and more acuminate, the disk paleæ lanceolate to oblanceolate, 4 to 5 mm long, slightly acuminate. Ray flowers few, 6 to 7 mm long; ligules oblong-elliptic, 4 mm long, 2 mm wide, yellow, entire or obscurely 2-toothed. Disk flowers perfect, 5 mm long. Achenes (immature) 2 mm long, their apices truncate, pilose, sometimes bearing a single straight bristle 0.5 to 1 mm long.

MINDANAO, Misamis Province, *For. Bur. 29751 Caster*, on the top of Angyar Ridge, altitude about 400 meters.

A species very strongly marked in its exceedingly narrow leaves. The collector indicates its height as about 1 meter, but does not state whether it is erect or scandent.

A FIELD EXPERIMENT IN THE CONTROL OF YAWS

By LEONCIO LOPEZ-RIZAL
Chief, Division of Communicable Diseases, Philippine Health Service

PERFECTUO GUTIERREZ
In Charge of Venereal and Skin-Diseases Clinic, Philippine Health Service

and

LORENZO FERNANDEZ
President, Sanitary Division, Parañaque, Rizal, Philippine Health Service

ONE TEXT FIGURE

Sixteen years have elapsed since the specific action of salvarsan in yaws was first demonstrated in the Philippines, and its specific action has since then been confirmed by other observations, from different parts of the Tropics. This drug, so potent and effective in the treatment of yaws, has not been used in attempts to eradicate the disease until recently. Salvarsan is wholly unsuited for routine work under field conditions. Its unsuitability has been largely overcome by the introduction of neosalvarsan, the price of which, however, was prohibitive for a time. A few years ago the Philippine Government was able to secure neosalvarsan at an almost nominal cost, for the purpose of investigating the possibility of the control of yaws.

In 1921 the Philippine Health Service opened a dispensary in Parañaque, Rizal Province, for the purpose of investigating the feasibility of extending yaws campaigns throughout the Philippines. Parañaque was chosen, because of its proximity to Manila and because it has been found to be a heavily infected town—a veritable "sore spot" to Manila, being about 6 kilometers from the southernmost boundary of the latter.

TOPOGRAPHY OF PARAÑAQUE, RIZAL PROVINCE

Parañaque lies along the eastern coast of Manila Bay. The principal streets are in close proximity to the seashore and the town itself is traversed by estuaries. Although the town is not under water at high tide or during the rainy season, yet it is

only a few meters above sea level. Indeed, the town is built along the shore of the bay, and its eastern side is limited by a branch of Parañaque River. The main occupations of the people are fishing and salt making.

EXTENT OF YAWS INFECTION

At the first house-to-house canvass, one hundred ninety-nine persons were found to be suffering from yaws in the granulomatous stage. During the first three months of treatment, forty-five more granulomatous cases were found, bringing the total up to two hundred forty-four, or 24.21 per 1,000 population, distributed in the barrios of the municipality. The reason for such heavy infection in Parañaque cannot be explained satisfactorily. Manila, with its poor population, more or less offers the same topography, habits, and hygiene, yet yaws cases are extremely rare there. The neighboring town Pasay, 2 kilometers north of Parañaque, is not so heavily infected, and only a few cases were found there. On the other hand, Las Piñas, about 3 kilometers south of Parañaque, is moderately infected. Apparently, these three towns have the same topography; the inhabitants and industries are similar, yet Parañaque is the only one that is heavily infected.

The dispensary was opened in September, 1921, and treatment was continued for three months, when all known cases were treated. The dispensary was then closed until September of the following year. It was originally hoped that it would be sufficient to operate the dispensary for a period of a few weeks, at intervals of about six months. New cases, however, were appearing so rapidly that the plan of intermittent operation was abandoned. After a partial resurvey in September, 1922, the dispensary was reopened and maintained continuously up to October 31, 1924 By that time there were no known cases existing in Parañaque. The dispensary was then closed for a period of six months and reopened in April, 1925. During the period from 1921 to 1924, two thousand five hundred forty-three cases were treated, one thousand one hundred fifty-one of which were among permanent residents and one thousand three hundred ninety-two among nonresidents, as shown in the following table:

TABLE 1.—*Showing the total cases of yaws treated in Parañaque from September, 1921, to October, 1924.*

Lesion.	Cases.		
	From Parañaque proper.	From neighboring towns.	Total.
Primary and secondary lesions	552	630	1,182
Tertiary lesions	599	762	1,361
Total	1,151	1,392	2,543

The majority of the tertiary group, about nine hundred, showed lesions consisting of keratosis palmaris and plantaris and bone changes. Cases of yaws, one thousand one hundred fifty-one in all, who were living in Parañaque were distributed in the different barrios of the town as shown in Table 2.

TABLE 2.—*Distribution of yaws cases in barrios of Parañaque.*

Barrio.	Estimated population.	Cases.
San Dionisio	2,975	513
La Huerta	1,587	152
Dongalo	2,293	216
Baclaran	3,250	155
Tambo	761	71
Ibayo	600	44
Total	11,466	1,151

The object of closing the clinic after several months of treatment was to learn what progress the infection would make and how soon new infections would take place, as it was believed that this information would prove useful in planning the best procedure for control. For this purpose, attention was limited to the residents of Parañaque in order to determine the number of infective cases at the time of the original survey and the number at the two subsequent resurveys, made at the reopening of the clinics.

The figures given in Tables 3 and 4 and the chart (fig. 1) show a marked fall in number of cases treated after the first period, from September to November, 1921, and a steady decline from then on to October, 1924. A much more significant

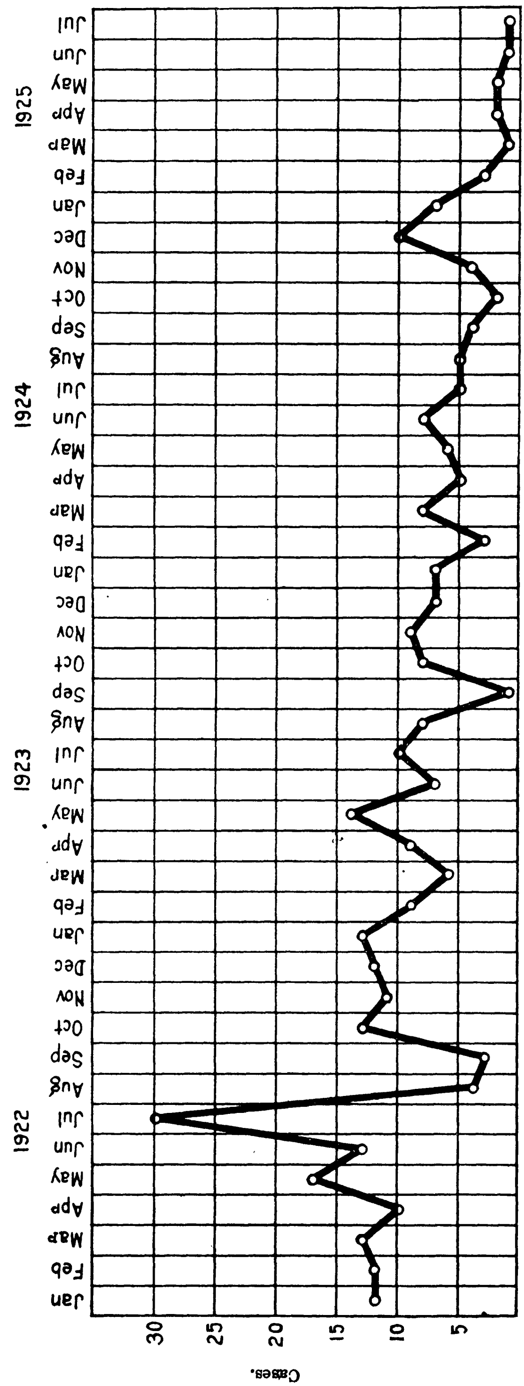


FIG. 1. New cases of yaws developing in Parañaque, by months of onset.

fall is observed after the last period, as shown by the number of cases treated from April to July, 1925.

TABLE 3.—*Showing yaws cases with primary and secondary lesions, treated in Parañaque, excluding those with tertiary lesions, by months.*

Month.	1921	1922	1923	1924	1925
January	0	0	12	15	0
February	0	0	15	16	0
March	0	0	16	18	0
April	0	0	17	7	19
May	0	0	11	0	2
June	0	0	13	12	1
July	0	0	12	0	12
August	0	0	7	11	---------
September	61	15	12	4	---------
October	145	28	13	17	---------
November	38	25	2	0	---------
December	0	20	10	0	---------
Total	244	89	129	90	34

The new cases developing each month in Parañaque are shown in Table 4. The time of onset of the disease was determined by the history of the patient and the clinical examination. The data in this table are shown more clearly in fig. 1.

TABLE 4.—*Showing new cases of yaws developing in Parañaque.*

Month.	1922	1923	1924	1925
January	12	13	7	7
February	12	9	3	3
March	13	6	8	1
April	10	9	5	2
May	17	14	6	2
June	13	7	8	1
July	30	10	5	1
August	4	8	5	---------
September	3	1	4	---------
October	13	8	2	---------
November	11	9	4	---------
December	12	7	10	---------
Total	150	101	67	17

The orginal estimate showed a total of two hundred forty-four granulomatous cases. Considering the care with which the survey was made and the treatment carried out, this figure may be accepted as reasonably accurate. Therefore, as seen from Table 3, three hundred forty-two new cases developed from December, 1921, to July, 1925, a period of nearly four years. This indicates

a heavier infection than was found at the beginning of the campaign; but, taking into consideration that the two hundred forty-four cases in 1921 were new infections that developed in less than two years, at the same rate we should have had around five hundred new cases had no campaign been undertaken. This shows that in opening a yaws campaign, the work should be pressed rapidly and thoroughly; in the long run, it will prove economical to do so, both in time and in money.

EPIDEMIOLOGICAL DATA

The disease has apparently no special seasonal prevalence, judging from the time the first lesions appear, as shown in Table 4. The cases, as shown by this table, are almost evenly distributed throughout the twelve months. Contact is the chief mode of infection. Multiple cases among the members of a single family are the rule in Parañaque. In one hundred ninety-nine cases studied, they were found distributed as shown in Table 5. Adults and children are equally susceptible, although more cases of primary and secondary lesions were found among children.

TABLE 5.—*Number of persons of a household that were infected with yaws.*

Families.	Cases.
49	1
28	2
10	3
7	4
3	5
2	6
0	7
1	8

TREATMENT

The dosage given was the same as is given to individuals suffering from syphilis, approximately 0.01 gram per kilogram of body weight, although a slightly higher dose was given to children and infants, who seemed to tolerate the drug better. Special care was taken to urge the patients to return for observation and for repeated injections. One or two injections cannot be counted on to effect complete recovery, though the patients were so markedly improved by one injection that the majority failed to return for further treatment. In fact, there were tertiary cases, although these were very rare, who had received eight or nine injections on account of the persistence of lesions. Table 1 shows the number of cases, including the tertiary.

It would be desirable to have a record of the result of the treatment in all cases treated at Parañaque; however, in view of the difficulties encountered, especially due to the transient habits of the fishermen which made it almost impossible to follow the entire group of patients individually throughout the period of approximately four years, one of us by careful investigation attempted to verify the results of the treatment in a representative and unselected number of patients. The findings, with the number of injections given in each case, are shown in Table 6.

TABLE 6.—*Results of treatment, showing the number of injections in a representative number of cases from Parañaque.*

Injections.	Cases recovered.	Cases improved.	Relapses.	Cases not recovered.
1	140	0	1	3
2	102	0	2	0
3	43	3	2	0
4	12	1	3	1
5	1	0	2	0
6	2	0	0	0
7	1	0	0	0
Total	301	4	10	4

As shown by Table 6, of three hundred nineteen cases followed up three hundred one, or 94.35 per cent, recovered and eighteen, or 5.65 per cent, improved, relapsed, or remained uncured. It must be said that six tertiary cases are included among the eighteen cases that were not cured.

After the dispensary had been closed for six months, thirty-four new cases were treated from April, 1925, to July 31, 1925. Of these new cases only thirty-one were new infections that occurred after the closing of the clinic, and the remaining three appear to have developed the eruptions before the clinic was closed. All showed only a primary granuloma, no secondary lesions having developed. The appearance of thirty-one new infections (see Table 4) in nine months shows that yaws, though essentially a chronic disease, can spread with fair rapidity. This is all the more striking when we consider that no recognizable focus of infection was present in Parañaque on October 31, 1924. Intermittent operation of a dispensary is obviously desirable, for the sake of economy; but our results show that, when the disease has been brought under control in a district once heavily infected, caution must be exercised in determining the length of time that treatment may be entirely suspended.

RELAPSES

Considering that a high proportion of cases received only one or two injections, the number of relapses is encouragingly small. There were only eighteen patients who showed recurrence or persistence of clinical symptoms among the three hundred nineteen who were reëxamined after treatment. Relapse commonly occurs within the first twelve months following the last injection, although it may occur after the first year. Table 7 shows the length of time, in months, after which relapses occurred in the ten cases recorded.

TABLE 7.—*Showing the length of time after which relapse occurred.*

Time after which relapse occurred.	Patients who received—				Total.
	1 injection.	2 injections.	3 injections.	4 injections.	
Months.					
0 to 6	1	2	1	----------	4
7 to 12	[a] 3	1	----------	[b] 1	5
13 to 18	----------	----------	----------	----------	----------
19 to 24	1	----------	----------	----------	1
Total	5	3	1	1	10

[a] One case relapsed twice, each time, with one injection, in the same length of time (seven to twelve months).

[b] Relapsed twice; the first time, with one injection, after six months, and the second, with four injections, after eight months.

COST OF TREATMENT

This work in yaws was carried out entirely by the medical officers regularly employed by the Philippine Health Service, in addition to their ordinary duties. The increase in the expenses occasioned by the treatment of the yaws cases, therefore, consisted merely in the expenditures for neosalvarsan and for the apparatus and material required in its administration. It was estimated that a clinic could be established for the minimum initial cost of 50 pesos [1] for equipment and an average cost of 1.20 pesos for neosalvarsan and other materials per patient.

OUTLOOK FOR THE CONTROL OF YAWS

It is not feasible at present to obtain even an approximate census of the yaws cases in the Philippines. A provisional survey showed the presence of at least forty thousand cases. There are probably three times this number and they are

[1] One peso Philippine currency equals 50 cents United States currency.

widely scattered throughout the Archipelago, from Batanes to Mindanao. Fortunately, however, they are unequally distributed and, of the forty thousand shown in the provisional survey, at least twenty-nine thousand were concentrated in thirteen centers; namely, Agusan, Batanes, Batangas, Ilocos Norte, Bulacan, Camarines Sur, Catanduanes, Cotabato, Ilocos Sur, Pangasinan, Rizal, Sulu, and Zamboanga Provinces, as shown in Table 8.

TABLE 8.—*Showing the number of cases of yaws treated with neosalvarsan in thirty-three provinces during 1923 and 1924.*

Province.	1923	1924	Total.
Agusan	551	857	1,408
Albay	3	1	4
Antique	28		28
Bataan	34	39	73
Batanes	337	790	1,127
Batangas	272	541	813
Bulacan	917	776	1,693
Cagayan		108	108
Camarines Sur	1,809		1,809
Catanduanes	77	1,241	1,318
Cavite		203	203
Cebu	2		2
Cotabato		5,834	5,834
Davao	306		306
Ilocos Norte	298	1,315	1,613
Ilocos Sur	240	257	497
Laguna	16		16
Lanao		17	17
La Union	7	6	13
Leyte		133	133
Mindoro		11	11
Misamis		33	33
Mountain	4	293	297
Nueva Ecija		82	82
Palawan	1		1
Pangasinan	423	1,680	2,103
Rizal	3,532	411	3,943
Samar		8	8
Sulu	524	5,489	6,013
Surigao	10	137	147
Tarlac	20	103	123
Zambales	718	10	728
Zamboanga	30	506	536
Total	10,159	20,881	31,040

With the progress of the treatment at Parañaque, patients in other districts became insistent in their demands for treatment. The immediate results at Parañaque were so encouraging that additional clinics were opened in some of the more heavily in-

fected localities. From 1921 to December 31, 1924, thirty-two thousand thirty-seven cases have been treated. Obviously, it will require many years yet to reach the outlying districts. Moreover, it is evident that the spread of yaws can be kept under control only at the price of persistent vigilance and intensive campaigning; otherwise, new cases will soon appear and the disease will regain a foothold. One of the most hopeful features is the quick and enthusiastic response on the part of the public. In Parañaque, a remarkable change in the attitude of the people has taken place in a short space of time. Only four, or even three, years ago the residents there accepted yaws uncomplainingly, as a necessary and unavoidable feature of life. Now the occurrence of a case of yaws is looked upon as a misfortune that cannot and must not be tolerated. This factor alone will go far toward assuring the eventual eradication of yaws in this community.

Although the results of treatment by neosalvarsan are extraordinarily brilliant, one desideratum remains; namely, a drug that can be used easily and painlessly by intramuscular injection. In the clinics in the Philippines, neosalvarsan is often used intramuscularly in infants, but only by intravenous injection in older patients. Of the other drugs used in yaws, Gilks (1) and Guerrero, Rosal, and Fernandez (2) have obtained excellent results with sodium potassium bismutho-tartrate by intramuscular injection. With this drug Gilks reports that the local reactions are about as severe as with neosalvarsan used intramuscularly. Moreover, severe stomatitis sometimes occurs.

Steadily increasing attention is being given to the control of yaws throughout the tropical world. In Granada, (3) at the close of 1922, nearly thirteen thousand cases were treated in a population of about sixty-six thousand. Gilks, in the Kenya Colony, East Africa, reports the treatment of twenty-four thousand two hundred thirty-three cases in 1922. By far the most extensive work has been conducted in the Dutch East Indies. Work was begun actively in 1920 and, by the end of the first half of the year 1923, the number of patients treated had reached the enormous figure of eight hundred ninety thousand. Neosalvarsan was used, each patient receiving only a single injection.

The opinion of all these workers is unanimous; namely, that yaws can be brought under control by destruction of the causative agent, *Treponema pertenue,* through treatment of the patients.

SUMMARY

1. Yaws has been brought under control in Parañaque, a district that has been heavily infected from time immemorial. During approximately four years one thousand one hundred fifty-one cases were treated.

2. The development of new cases of yaws in infected communities is moderately rapid. In Parañaque, three hundred forty-two new cases developed in three years. After all known cases were treated, thirty-one new cases developed in nine months.

3. Intermittent operation of yaws dispensaries is not a satisfactory procedure for the control of the disease in very heavily infected communities.

4. Intensive treatment and persistent vigilance, so as to assure complete recovery of existing cases, is the most important factor in the control of the disease.

REFERENCES

1. GILKS, J. L. Trans. Roy. Soc. Trop. Med. and Hyg. 17 (1923) 277.
2. Report from the Colonial Office, Trop. Dis. Bull. 20 (1923) 843.
3. WINKEL, CH. W. F. Mededeelingen van den Burgerlijken Geneeskundigen Dienst in Nederlandsch Indie, Part 3 (1923) 213.

ILLUSTRATION

TEXT FIGURE

FIG. 1. Chart showing new cases of yaws developing in Parañaque, by months of onset.

A SEROLOGICAL ESTIMATE OF THE EFFICACY OF NEOSALVARSAN IN THE TREATMENT OF YAWS IN A FIELD DISPENSARY [1]

By REGINO J. NAVARRO

Of the College of Medicine, University of the Philippines

Within the past five years the treatment of yaws was begun on an extensive scale in many parts of the Tropics. The campaigns for the control of yaws have developed so rapidly that the work is already assuming world-wide proportions. The success of these campaigns has been due to various factors, more especially to the facility with which neosalvarsan can be injected, even under field conditions; to the unfailing popularity of the clinics with yaws patients; and also, in no small measure, to the enthusiasm of the physicians and attendants in charge of the clinics.

The very brilliancy of the effects of a single injection of neosalvarsan carries with it some measure of disadvantage, in that many patients do not bother to return for continued treatment. Accurate information concerning the incidence of relapses or reinfections has been difficult to secure, in view of the very nature of the conditions under which the field clinics are operated. Under the direction of Dr. L. Lopez-Rizal, of the Philippine Health Service, a field clinic was conducted at Parañaque, in which it was possible to follow the patients during a period of several years. In this clinic, Lopez-Rizal, Gutierrez, and Fernandez [2] noted clinical evidence of relapses in almost 6 per cent of three hundred nineteen patients who were treated during the granulomatous stage of the disease.

In the work the Wassermann reaction was used to determine the efficacy of treatment under the purely practical circumstances that existed in the field work at Parañaque. Of the five hundred fifty-two patients treated in the granulomatous stage at Parañaque, one hundred one were taken without se-

[1] From the department of pathology and bacteriology, College of Medicine, and the department of laboratories, Philippine General Hospital.

[2] Antea, 437.

lection for the Wassermann test. The majority of these patients were children of school age. The treatment they received varied from one to five intravenous injections of neosalvarsan. The lapse of time between the last treatment and the examination of the blood varied from three months to three and one-half years.

The Wassermann reaction was carried out according to the technic described by Hinton.[3] Two units of antisheep-rabbit amboceptor and two units of complement of guinea-pig serum were used. Sheep cells were employed in approximately 5 per cent suspension, the uniformity of the suspension being controlled by a color standard. The only antigen used was a cholesterinized alcoholic extract of beef heart.

As emphasized by Goodpasture and de Leon,[4] it may be considered as established that the Wassermann reaction is constantly and strongly positive in the active secondary stage of yaws. Consequently, in the cases reported in this paper it can be safely assumed that the Wassermann reaction was positive before the treatment with neosalvarsan. For the correct interpretation of the following results it is important to note that Goodpasture and de Leon found that, in patients under treatment with neosalvarsan, the Wassermann reaction did not disappear coincidently with the healing of the skin lesions. However, after the cessation of treatment, the reaction gradually weakened and eventually became negative. Therefore, it is usually necessary to allow several months to elapse after the last injection of neosalvarsan, in order to determine the final effect of treatment as judged by the Wassermann reaction.

Of the one hundred one patients who were tested, eighty-three, or 82 per cent, gave entirely negative results. In eight cases, a trace of inhibition (+) was observed, but in our experience this degree of inhibition is almost without significance in this community. It so happened that a ++ reaction (50 per cent hæmolysis) was observed in only one case. There were six patients giving a +++ result (75 per cent inhibition) and three who showed complete inhibition (++++). Thus, there were only ten cases (10 per cent) giving a definitely positive Wassermann test.

For the convenience of the reader, the patients are grouped in the tables according to the result of the Wassermann reac-

[3] Am. Journn. Syph. 4 (1920) 598.

[4] Philip. Journ. Sci. 22 (1923) 221.

tion, and arranged according to the period of time elapsing between the last treatment with neosalvarsan and the date of the Wassermann test. All of the patients who gave an entirely negative reaction are recorded in Table 1.

TABLE 1.—*Record of patients giving a negative Wassermann reaction.*

Serial No.	Date of treatment with neosalvarsan.			Date of Wassermann test.	Interval between treatment and Wassermann test.
	First injection.	Second injection.	Third injection.		
					Months.
1	Oct. 19, 1924			Feb. 6, 1925	3½
2	Sept. 20, 1924			do	5
3	Jan. 9, 1920	Feb. 5, 1924	[a] Feb. 19, 1924	Mar. 5, 1925	5½
4	Oct. 7, 1922	Aug. 11, 1923	June 14, 1924	Apr. 6, 1925	9¾
5	Sept. 22, 1921	Oct. 3, 1925		Dec. 2, 1924	10
6	Oct. 9, 1920	Oct. 19, 1922	[b] Sept. 22, 1923	Nov. 13, 1924	13
7	Oct. 12, 1922	Apr. 28, 1923		Apr. 6, 1925	13¼
8	Dec. 22, 1923			Feb. 2, 1925	13⅓
9	Nov. 7, 1922	Dec. 21, 1922	Apr. 16, 1923	Apr. 6, 1925	13¾
10	Nov. 27, 1923			Mar. 23, 1925	15¾
11	Nov. 11, 1922	Jan. 6, 1923		Apr. 6, 1925	17
12	July 17, 1923			Nov. 21, 1924	17
13	Sept. 26, 1921	July 10, 1923		Feb. 2, 1925	17¾
14	May 3, 1923			Nov. 21, 1924	18½
15	Jan. 11, 1923	Aug. 11, 1923	Aug. 18, 1923	Apr. 6, 1925	19¾
16	Jan. 29, 1923			Dec. 2, 1924	22
17	Oct. 26, 1922	May 10, 1923		Apr. 6, 1925	22¾
18	Nov. 9, 1921	Dec. 12, 1922		Nov. 21, 1924	23¼
19	Jan. 25, 1923	Feb. 1, 1923	[c] Feb. 8, 1923	Feb. 2, 1925	28½
20	Oct. 14, 1922			Dec. 2, 1924	25¾
21	Sept. 28, 1922			do	26
22	Oct. 26, 1922	Nov. 4, 1922	Dec. 9, 1922	Feb. 6, 1925	26
23	Oct. 21, 1922	Dec. 23, 1922		Mar. 5, 1925	27
24	Dec. 2, 1922			do	27
25	Oct. 14, 1922	Nov. 4, 1922		Feb. 6, 1925	27
26	Nov. 21, 1922	Dec. 5, 1922		Mar. 16, 1925	27¼
27	Oct. 19, 1922			Feb. 6, 1925	27½
28	Dec. 5, 1922			Mar. 23, 1925	27¾
29	Oct. 12, 1922			Feb. 6, 1925	27¾
30	Nov. 4, 1922	Nov. 11, 1922	Nov. 21, 1922	Mar. 23, 1925	28
31	Oct. 24, 1922			Mar. 5, 1925	28¼
32	Oct. 21, 1922			do	28½
33	Oct. 17, 1922			do	28½
34	Oct. 3, 1921	Nov. 7, 1921	Oct. 24, 1922	Mar. 16, 1925	28¾
35	Oct. 19, 1922	Nov. 2, 1922		Mar. 23, 1925	28¾
36	Oct. 14, 1922			Mar. 5, 1925	28¾
37	Sept. 26, 1922	Oct. 5, 1922		Mar. 16, 1925	29¼
38	Sept. 22, 1922	Oct. 7, 1922		Mar. 23, 1925	29½
39	Nov. 14, 1922			Mar. 5, 1925	29¾
40				Mar. 23, 1925	[d] 30

[a] Fourth injection, September 20, 1924; fifth injection, September 30, 1924.
[b] Fourth injection, October 6, 1923.
[c] Fourth injection, February 15, 1923.
[d] Approximate; exact record of treatment not available.

TABLE 1.—*Record of patients giving a negative Wassermann reaction*—Ctd.

Serial No.	Date of treatment with neosalvarsan.			Date of Wassermann test.	Interval between treatment and Wassermann test.
	First injection.	Second injection.	Third injection.		
					Months.
41				Apr. 6, 1925	[d] 30
42	Sept. 26, 1922	Oct. 12, 1922		do	30⅓
43	Nov. 8, 1921	Nov. 17, 1921		Nov. 13, 1924	35⅔
44	Sept. 12, 1921	Oct. 3, 1921		Oct. 13, 1924	36⅓
45	Sept. 19, 1921	Oct. 3, 1921		do	36⅓
46	Nov. 3, 1921			Nov. 13, 1924	36⅓
47	Sept. 12, 1921	Sept. 26, 1921		Oct. 13, 1924	36½
48	Oct. 27, 1921			Nov. 13, 1924	36½
49	Sept. 15, 1921	Oct. 27, 1921		do	36½
50	Oct. 10, 1921	Oct. 26, 1921		do	36½
51	Oct. 31, 1921			Nov. 21, 1924	36⅔
52	Oct. 27, 1921			do	36⅔
53	Oct. 31, 1921			do	36⅔
54	Sept. 15, 1921			do	36⅔
55	Sept. 26, 1922			do	36⅔
56	Oct. 29, 1921			Dec. 2, 1924	37
57	Nov. 3, 1921			do	37
58	Oct. 10, 1921			Nov. 13, 1924	37
59	Sept. 12, 1921			Dec. 2, 1924	37⅙
60	Sept. 19, 1921	Oct. 3, 1921		Nov. 13, 1924	37⅓
61	Sept. 12, 1921	do		Nov. 21, 1924	37½
62	Sept. 19, 1921	do		do	37½
63	Sept. 26, 1921			do	37⅔
64	Sept. 10, 1921	Sept. 29, 1921		Dec. 2, 1924	38
65	Sept. 12, 1921			Nov. 13, 1924	38
66	Sept. 22, 1921			Dec. 2, 1924	38⅙
67	do			do	38⅓
68	Oct. 26, 1921			Feb. 2, 1925	39
69	Oct. 27, 1921			Mar. 5, 1925	40
70	Sept. 28, 1922			Apr. 6, 1925	40
71	Nov. 10, 1921			Mar. 16, 1925	40¼
72	Oct. 27, 1921	Nov. 10, 1921		Mar. 23, 1925	40⅓
73	Oct. 31, 1921			Mar. 16, 1925	40½
74	Oct. 19, 1921	Oct. 31, 1921		do	40½
75	Oct. 13, 1921	Oct. 27, 1921		do	40⅔
76	Oct. 31, 1921			Mar. 23, 1925	40⅔
77	Oct. 24, 1921			Mar. 16, 1925	40⅔
78	Oct. 20, 1921			Mar. 23, 1925	41
79	Oct. 24, 1921			do	41
80	Sept. 26, 1921	Oct. 26, 1921	Oct. 31, 1921	Apr. 6, 1925	41
81	Oct. 13, 1921			Mar. 16, 1925	41
82	Sept. 29, 1921	Oct. 6, 1921		do	41⅓
83	Sept. 22, 1921	Oct. 3, 1921		Mar. 23, 1925	41⅔

[d] Approximate; exact record of treatment not available.

Of the eighty-three patients giving an entirely negative result forty-three, or 51+ per cent, received only one injection and twenty-eight received two injections, with an interval usually of one to two weeks between the injections. Occasionally this interval was as long as three years. Only ten, or 12 per cent, of these negative cases received more than two injections. Seven were injected three times, two were given four injections, and one patient was given five injections. In two cases (40 and 41) the exact number of injections could not be ascertained.

The patients who showed a positive Wassermann reaction were retested after an interval of several months, and they were also examined clinically. The results are shown in Table 2.

There were eighteen patients who gave a positive Wassermann test. Eight of this group gave a very weak Wassermann reaction (+). Only one of the eight received treatment in the interval between the first and the second blood tests. On repetition of the Wassermann test five of the eight patients had become negative, and one showed a three-plus reaction. Two members of this group (the one-plus group) could not be seen for a second Wassermann test and for clinical examination. As seen in Table 2, all of the patients examined clinically in the one-plus group gave negative findings. In case 89, whose one-plus reaction was obtained twenty-nine months after the single injection, the blood showed a three-plus reaction four months after the first test, or thirty-two months after the treatment. Clinically this case was entirely negative at the time the blood for the second test was taken.

There was only one patient (92) who gave a two-plus reaction. Four and one-half months after the first Wassermann reaction on this case the blood became three-plus, and fresh ulcers on both legs were seen. This patient and all of those in the following (three-plus) group showed positive clinical findings, except in one instance (case 93). The clinical manifestations were in the form of keratosis plantaris with or without ulcers or fissures, enlarged epitrochlear glands, or fresh ulcers. As shown in the second blood examination, no patient in the three-plus group showed any change in the strength of the Wassermann reaction after an interval of from one and one-half to seven months. It is important to note that all of these patients, including the single case that gave a two-plus reaction, had received only a single injection.

TABLE 2.—*Record of patients giving positive Wassermann reaction.*

Serial No.	Date of treatment with neosalvarsan.		First Wassermann test.		Interval between last treatment and first Wassermann test.	Second Wassermann test.		Interval between Wassermann tests.	Remarks.
	First injection.	Second injection.	Result.	Date.		Result.	Date.		
					Months.			*Months.*	
84	May 26, 1923	----------	+	Feb. 2, 1925	20¼	—	July 3, 1925	5	Negative clinically, July 3, 1925.
85	Sept. 22, 1921	[a] Oct. 3, 1921	+	Oct. 13, 1924	22½	—	----do----	8⅔	Do.
86	Nov. 11, 1922	Dec. 7, 1922	+	Feb. 6, 1925	26	----------	----------	----------	Patient could not be located for clinical examination and second examination of blood.
87	Nov. 7, 1922	----------	+	----do----	26	—	July 3, 1925	5	Negative clinically, July 3, 1925.
88	Sept. 28, 1922	[b] Dec. 5, 1922	+	Apr. 6, 1925	28	—	June 30, 1925	2	Negative clinically, June 30, 1925.
89	Oct. 19, 1922	----------	+	Mar. 16, 1925	28¾	+++	July 17, 1925	4	Negative clinically, July 17, 1925.
90	Sept. 15, 1921	----------	+	Nov. 13, 1924	37¾	----------	----------	----------	Patient could not be located for second blood test and clinical examination.
91	Nov. 4, 1922	Nov. 18, 1922	+	Feb. 2, 1925	38¾	—	July 3, 1925	5	Negative clinically.
92	Oct. 14, 1922	----------	++	Feb. 6, 1925	27⅔	+++	June 30, 1925	4½	Fresh ulcers on both legs, June 30, 1925.
93	Sept. 19, 1921	----------	+++	Nov. 21, 1924	38	+++	July 3, 1925	7½	Negative clinically, June 30, 1925.
94	Nov. 11, 1922	----------	+++	Feb. 2, 1925	38⅔	+++	May 19, 1925	3½	Epitrochlear glands enlarged, May 15, 1925.
95	Oct. 18, 1922	----------	+++	----do----	39½	+++	----do----	3½	Keratosis plantaris, May 15, 1925.
96	Oct. 31, 1921	----------	+++	Apr. 6, 1925	41	+++	----do----	1½	Keratosis plantaris with ulcers, May 15, 1925.
97	Sept. 19, 1921	----------	+++	Mar. 16, 1925	41¾	+++	----do----	2	Keratosis plantaris with ulcers in big toes, May 15, 1925.
98	Sept. 22, 1921	----------	+++	Mar. 23, 1925	42	+++	----do----	2	Keratosis plantaris with fissures, May 15, 1925.
99	Oct. 14, 1921	[c] Oct. 17, 1922	++++	Mar. 16, 1925	25¾	++++	May 8, 1925	3⅔	Apparently negative clinically, May 5, 1925.
100	Oct. 19, 1922	----------	++++	Feb. 2, 1925	27½	++++	May 19, 1925	3½	Enlarged epitrochlear glands; fresh ulcers on both legs.
101	Oct. 12, 1922	Oct. 19, 1922	++++	Mar. 16, 1925	29	++++	July 3, 1925	3½	Apparently negative clinically, June 30, 1925.

[a] Third injection, November 21, 1922; fourth injection, November 28, 1922.
[b] Third injection, July 2, 1925; fourth injection, July 9, 1925; fifth injection, July 16, 1925.
[c] Third injection, October 24, 1922.

There are three cases in the last group (four-plus group). All of them showed complete inhibition in both the first and the second blood examinations. In all of them it happened that the second test was made a little more than three months after the first examination of the blood. In two of these cases (99 and 101) no clinical manifestations could be seen. In one patient (100) enlarged glands and fresh ulcers were found when the blood for the second test was taken. Incidentally, only one injection was given to this case while cases 99 and 101 had received two and three injections, respectively.

In Table 3 the results of the Wassermann test are arranged according to the number of injections that the patients received. These injections were given at short intervals, making a continuous course of treatment, except in eight instances.

TABLE 3.—*Classification of Wassermann results according to the number of injections given in treatment.*

Injections per patient.	Total cases.	Wassermann reaction.				
		Negative cases.	+ cases.	++ cases.	+++ cases.	++++ cases.
1	55	43	4	1	6	1
2	31	28	2			1
3	8	7				1
4	3	2	1			
5	2	1	1			

From Table 3 it is seen that a single injection of neosalvarsan was followed by a completely negative Wassermann reaction in forty-three of fifty-five cases (78 per cent). This result is very striking, but it cannot be accepted as final proof that the infection with treponemata had been entirely eradicated in all of the cases giving a negative Wassermann reaction. The interval of time elapsing between the injection with neosalvarsan and the examination of the blood varied from three and one-half to forty-one and two-thirds months. Of the thirty-one patients who received two injections, twenty-eight gave an entirely negative reaction and only one gave a definitely positive test.

The dosage of neosalvarsan for these patients varied from 500 or 600 milligrams for adults to 75 milligrams for infants 2 years or less of age. Patients of intermediate ages were given proportionate amounts.

SUMMARY

1. The Wassermann reaction in one hundred one yaws patients treated with neosalvarsan at the field clinic in Parañaque was made three months to three years after the cessation of treatment.

2. Eighty-three of these, or 82 per cent, gave an entirely negative reaction. Ten of them gave decidedly positive tests, two-plus, three-plus, or four-plus.

3. Of the eighty-three patients giving a negative reaction forty-three, or 51 per cent, received only one injection.

4. Fifty-five of the one hundred one patients included in this report received only one injection. Of these fifty-five cases, forty-three were negative and four gave a one-plus reaction.

5. Of the eighteen patients giving a positive Wassermann reaction, seven showed clinical manifestations of yaws. One of these is the single case giving a two-plus reaction, five are in the three-plus group, and one is in the four-plus group.

INVESTIGATION OF IMMUNITY IN YAWS [1]

By GEORGE RUFUS LACY

Of the International Health Board and the Bureau of Science

and

ANDREW WATSON SELLARDS

Of the Harvard Medical School, Department of Tropical Medicine, and the Bureau of Science

ONE PLATE

The question of immunity in yaws has been investigated by the inoculation of patients who have been cured, or at least apparently cured, with injections of neosalvarsan. In employing this procedure as a method for the study of immunity one encounters the difficulty of establishing absolutely that treatment by neosalvarsan has entirely eradicated the treponemata. Consequently, it becomes difficult to determine whether resistance to reinfection is due to an active immunity or to the persistence of low-grade infection. However, since the inoculations were made in patients, the results, regardless of their theoretical interpretation, are immediately applicable in the practical problem of the control of yaws. In 1922 this method was employed for the study of a small group of cases.[2] Six months after treatment with neosalvarsan, four patients were inoculated by implanting a small fragment of a yaws granuloma in an incision in the skin. One of the patients was readily susceptible, but the other three were more or less refractory to reinfection. Two of the four cases developed lesions of sufficient extent to require treatment with neosalvarsan.

After an interval of more than two years the susceptibility of these four patients to yaws was tested again by reinoculation. They had received no further treatment in the meantime, and they continued to live in Parañaque, a district thoroughly infested with yaws. In the following description of our results the numbers of the cases agree, of course, with

[1] From the Bureau of Science, Manila.

[2] Sellards, A. W., and E. W. Goodpasture, Philip. Journ. Sci. 22 (1923) 233.

those used in the previous report. These patients were discharged from observation in July, 1922, and were next seen in September, 1924. At the latter date, none showed any lesions of the skin nor any signs of involvement of the lymphatic glands or the bones. The Wassermann reaction was entirely negative in three of the cases and in one (No. 4) there was a mere trace of inhibition of hæmolysis. A month later the Wassermann reaction was repeated, with the same result.

On October 11, 1924, these patients were reinoculated with yaws, by implanting pieces of tissue, rich in treponemata, in a skin incision over the deltoid. These fragments of tissue were selected from an early yaw, before the crust had formed. As a precautionary measure, smears were examined for contaminating organisms, particularly the streptococci, but none were found. The results of the reinoculation varied only in detail from those shown in these patients in 1922. The data are summarized in Table 1.

TABLE 1.—*The reinoculation of yaws in cases treated with neosalvarsan.*

Case No.	Preliminary record of patient.			
	Duration of disease.		Wassermann reaction before treatment.	Date of treatment with neosalvarsan.
	Yrs.	*mos.*		1921
1		3	++++	September–October.
2	1	(++)	++++	Do.
3	2	(—)	++++	Do.
4		8	++++	Do.

Case No.	First reinoculation with yaws.				
	Date.	Wassermann reaction before first reinoculation.	Clinical results.	Wassermann reaction after first reinoculation.	Treatment with neosalvarsan.
1	March 9, 1922	0	Typical granuloma, early secondary lesions after five weeks.	April 6, 0	April, 1922.
2	do	±	No typical lesion	May 16, +	None.
3	do	0	do	March 30, 0	None.
4	do	0	Granuloma, clinically atypical, no secondary lesions after four months.	March 30, ±	July, 1922.

TABLE 1.—*The reinoculation of yaws in cases treated with neosalvarsan*—Continued.

Case No.	Second reinoculation with yaws.			
	Date.	Wassermann reaction before second reinoculation.	Clinical results.	Wassermann reaction after second reinoculation.
	1924			1924–1925
1	October 11	0	Typical granuloma, secondary lesions in scalp after one and three-fifths months.	November 29, ++.
2	do	0	No lesions	April 30, ++.
3	do	0	Abortive atypical reaction	April 30, ++.
4	do	±	do	June 30, 0.

For the interpretation of these results one must remember that, as far as we know, there is no natural immunity to yaws. With good material and with a little technical care, normal individuals can be inoculated successfully without difficulty. It is important to note (see Table 1) that in the second reinoculation of these patients, as in the first, there were no absolutely negative reactions. The results of the second reinoculation require some detailed description. The intervals of time are dated from the inoculation of October 11, 1924. In the first case, one week after inoculation, the faint line where the skin incision had been made was very slightly hyperæmic. At the end of the second week, the line of the incision was slightly elevated, and at its center there was a yellow spot the size of a pinhead, surrounded by a narrow zone (2 millimeters) of hyperæmia. This enlarged rapidly, appearing one week later as an oval lesion, 5 millimeters long. At the end of the fifth week after inoculation there was a characteristic yaw, 1.5 centimeters in diameter, with a yellow crust. The Wassermann reaction one week later showed about 50 per cent hæmolysis (++).[3] In the succeeding weeks, this primary yaw, instead of showing typical rapid growth, remained almost stationary and even regressed slightly at some places along its margin but advanced slowly at other places.

[3] Throughout this paper the Wassermann reactions are reported as follows: +, almost complete hæmolysis; + +, about 50 per cent hæmolysis; + + +, about 75 per cent inhibition; + + + +, complete or almost complete inhibition of hæmolysis.

In as much as no secondary lesions had developed at the end of seven weeks after inoculation, we performed a subinoculation. The condition of the primary yaw at this date is shown in Plate 1, fig. 1. A fragment of the primary yaw showing typical treponemata in the dark field was inoculated, as before, in skin incisions over the deltoid on the same arm and on the opposite arm. These healed promptly without even the development of any hyperæmia. The failure of this autoinoculation must not be confused with the successful autoinoculations obtained in patients during the initial attack of yaws. After an interval of three and one-third months the primary yaw showed some signs of regression, and the epidermis surrounding it was roughened and depigmented, the papillæ standing out prominently (Plate 1, fig. 2).

After five months, there was still no secondary eruption. At the end of six months, however, we found numerous typical granulomata limited almost exclusively to the scalp. By way of contrast, in the spontaneous infection of this patient, the secondary eruption appeared about one month after the mother yaw was noticed, the granulomata showing the usual distribution over the body, appearing on the face, neck, in the right axilla, and over the chest, abdomen, and legs.

The secondary eruption in the scalp was accompanied by the appearance over the body of an unusual macular exanthem. This will be discussed more fully in a subsequent paper.[4] There was also a general enlargement of the superficial lymphatic glands, particularly the posterior cervical and auricular glands. The infection was terminated at this stage by treatment with neosalvarsan.

To summarize, the points of interest in the first case are the prompt appearance of a typical yaw at the site of inoculation; its subsequent slow growth; the failure of autoinoculation; and the very late appearance of secondary granulomata, atypical in their distribution and accompanied by a macular rash.

In the second patient, the inoculation was followed by prompt healing without hyperæmia and with no elevation of the epidermis along the line of the incision. Locally, therefore, the result was entirely negative. Six and one-half months after inoculation, the blood showed a ++ Wasermann reaction. This result raises the question of the possible development of a low-grade infection insufficient to produce any clinical signs or

[4] Postea, 478.

symptoms. This patient is still under observation. He is in robust health, quite unlike his general appearance when he was first seen four years ago, toward the end of the secondary stage of his spontaneous attack of yaws. The development of a positive Wassermann reaction suggests an analogy with those yaws patients in whom the granulomata have disappeared spontaneously but in whom the blood continues to show a positive Wassermann reaction for several years.

The third patient showed comparatively little reaction at the site of inoculation. At the end of two weeks, in the line of the skin incision there was a slightly elevated ridge, 2 millimeters long and 1 millimeter wide. This was slightly pink at the edges. One week later this ridge had increased in size (5 by 1.5 millimeters) ; the rete Malpighii in it were prominent. There was a white zone of depigmentation at the edges and this, in turn, was surrounded by a pink areola. In the succeeding weeks, this lesion regressed slowly, becoming dry without definite desquamation; it disappeared completely by the end of the seventh week after inoculation. A blood specimen taken six and one-half months after inoculation showed a positive Wassermann reaction (++).

The fourth case showed a definite local change at the site of inoculation that was not granulomatous in character. Indeed, it was unlike any of the ordinary lesions of yaws, but resembled the lesion developing in case 3, though more intense. It also had certain features in common with the zone of depigmentation which eventually appeared around the granuloma developing in case 1 (Plate 1, fig. 2). The reaction started promptly. One week after inoculation, in the middle of the skin incision, there was a yellow spot the size of a pinhead. The epidermis around this was slightly raised and surrounded by an irregular pinkish areola. For the next three weeks, this lesion increased slowly in size and then began to regress. One week later, that is, five weeks after inoculation, the lesion was dry and desquamating, but was surrounded by an irregular zone, 1 to 2 centimeters in width, of hard white papules of pinhead size. These were scalelike in appearance and, when firmly scraped, did not leave any bleeding points. The appearance at the end of the seventh week is shown in the accompanying photograph (Plate 1, fig. 3). This lesion, surrounding the original inoculation, regressed slowly without any evident desquamation; by the end of the tenth week after inoculation it had diminished markedly, but traces of the lesion were still

present three and one-third months after inoculation (Plate 1, fig. 4). This patient will be discussed more fully in the consideration of some of the unusual skin lesions of yaws.[5] The Wassermann reaction, eight and one-half months after inoculation, was negative.

DISCUSSION

Three of these four cases (Nos. 2, 3, and 4) had been infected with yaws for a fairly long period at the time of their first course of treatment with neosalvarsan, and they showed distinct resistance to reinfection upon experimental inoculation with yaws. It is ordinarily assumed that thorough treatment of a yaws patient with neosalvarsan accomplishes an actual cure of the infection, but this opinion may be open to question in view of the resistance to reinfection that was observed in these treated patients. If it could be established that the treatment resulted in complete destruction of the treponemata, then this resistance to reinfection would afford satisfactory evidence of the development of acquired immunity to yaws in man. At present, no final decision is possible. To workers who are familiar with syphilis only, the temptation is strong to ascribe this resistance to a latent infection with yaws. However, the weight of evidence appears to us to be in favor of an active immunity. Yaws is a disease sui generis, and many facts do not apply to it which are well demonstrated for syphilis. *Treponema pertenue* is but slightly invasive, as compared with *Treponema pallidum*, and it responds very readily to therapeutic measures. Thorough treatment of these four cases with neosalvarsan restored the Wassermann reaction to normal and resulted in complete freedom from clinical signs or symptoms for more than two years. This period of time is by no means sufficient to insure freedom from a possible relapse. Yet, until there is evidence to the contrary, it seems to us that the burden of proof rests with those who would maintain that each of the three patients who were resistant to inoculation carried a latent infection.

Comparing the results of the first and the second reinoculations, each of the four patients on the second test showed a little increase in his resistance to reinfection. This suggests that the first reinoculation resulted in a slight increase in the degree of immunity. At least, this view seems more natural than the alternative assumption of an increase in the "degree of latent infection."

[5] Postea, 475.

Latent infection in yaws is often seen, especially in untreated cases of long standing. Fortunately, a low-grade infection with yaws does not carry with it the menacing dangers characteristic of syphilis. Therefore, regardless of the theoretical interpretation, the practical results of this test of reinoculation are extremely satisfactory. It seems clear that a considerable proportion of yaws cases, after treatment with neosalvarsan, will possess considerable resistance to reinfection for a long period of time. This evidence, indicating the permanency of the good results of treatment, fully justifies and encourages the efforts now being made to bring yaws under control.

SUMMARY

The following observations have been made upon the question of immunity to yaws in man:

Four yaws patients were treated with neosalvarsan and, after an interval of about six months, they were inoculated with yaws. One developed a characteristic granuloma, and the others showed atypical results. Treatment with neosalvarsan was repeated in two of these cases and in the other two the lesions soon disappeared spontaneously. After more than two years, these four patients were found to be free from any clinical signs or symptoms of yaws and the Wassermann reaction was negative. They were then reinoculated with yaws, and only one developed a typical granuloma, the same one who was susceptible in the previous test. At the time of the first course of treatment with neosalvarsan this patient had had yaws for only three months; the others had been infected for much longer periods. Therefore, three of these four patients showed well-marked resistance to reinfection with yaws. This resistance to reinfection might be explained either by the development of an active immunity or by the continuance of a latent infection with yaws. In the absence of information permitting a final decision, we have adopted as a working basis the view that active immunity develops late in the secondary stage of yaws.

It is of considerable practical significance that yaws patients, treated in the advanced secondary stage of infection, have remained in excellent health, free from any symptoms of yaws, and that they retained well-marked resistance to reinfection for more than two years. This period of time is ample to permit bringing the disease under control even in heavily infected districts.

ILLUSTRATION

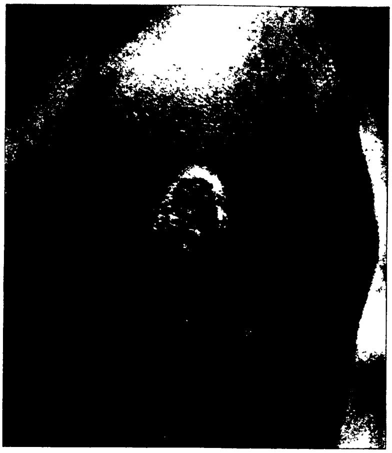
PLATE 1. YAWS PATIENTS TREATED WITH NEOSALVARSAN AND SUBSEQUENTLY INOCULATED WITH YAWS

FIG. 1. Case 1. Primary granuloma seven weeks after inoculation.

2. Case 1. The same lesion three and one-third months after inoculation.

3. Case 4. Atypical lesion seven weeks after inoculation.

4. Case 4. The same lesion showing spontaneous regression; three and one-third months after inoculation.



1

2

3

4

PLATE I.

SUPERINFECTION IN YAWS [1]

By ANDREW WATSON SELLARDS

Of the Harvard Medical School, Department of Tropical Medicine, and the Bureau of Science

GEORGE RUFUS LACY

Of the International Health Board and the Bureau of Science

and

OTTO SCHÖBL

Of the Division of Biology and Serum Laboratory, Bureau of Science

SIX PLATES

The many points of similarity between syphilis and yaws have been emphasized repeatedly, and at times almost to the exclusion of some of the striking differences between the two diseases. It is well established that a typical chancre cannot be produced in a patient already infected with syphilis. The following investigation was carried out to determine whether superinfection is possible in yaws.

Many observations have been recorded concerning the effects of autoinoculation or reinoculation of syphilitic patients with syphilis. The details of the facts are somewhat beclouded on account of the incompleteness of many of the experimental and clinical observations. The data are sometimes limited to a description of the clinical effects, without exact information concerning the presence of treponemata in the lesions under consideration. However, the literature on superinfection has been carefully analyzed by Neisser. [2] He states that, if a normal person were to be inoculated with syphilis every day, say, for one month, the first ten or fifteen inoculations would give rise to entirely typical primary chancres, but the subsequent inoculations would produce only abortive atypical reactions, or might even give entirely negative results.

[1] From the Bureau of Science, Manila.

[2] Arb. aus. d. kais. Gesundheitsamt 37 (1911) 155.

Only a few observations have been recorded concerning the reinoculation of yaws patients. Charlouis[3] reported the production of typical granulomata following the reinoculation of patients in the active stage of yaws and of persons who had recovered spontaneously from yaws. The experiments of Charlouis were excellently conceived, but were carried out long before control by the Wassermann reaction or examination for treponemata was possible. It seems evident that his results were frequently complicated by secondary infection at the site of inoculation. That a typical attack of yaws will be produced by inoculation of a spontaneously healed patient is at variance with the evidence of clinical experience and with our own results. Jeanselme and Angier[4] reinoculated a patient in the fourth month of the disease, and again in the fifth month, but with entirely negative results. Powell[5] recently performed autoinoculations in eleven cases of yaws, with entirely negative results. We have already reported[6] the results of reinoculation of patients in the tertiary stage of yaws (clavos) or in the late secondary stage, choosing patients in whom the granulomata were already disappearing spontaneously. Some abortive reactions developed but, as might have been expected, no typical granulomata were produced.

In the early stage of yaws secondary granulomata develop spontaneously and, therefore, one can naturally expect to produce superinfection artificially by experimental inoculation. Clinical histories of yaws patients are necessarily inaccurate regarding the time of onset of the disease. We have, therefore, produced yaws experimentally in a group of six volunteers in order that we might know the exact time of inoculation and the first appearance of clinical symptoms. The patients were then reinoculated at varying intervals to determine whether superinfection would produce typical granulomata showing *Treponema pertenue*. These volunteers were selected from a group of individuals who had never lived in a yaws district and in whom there was no suspicion whatever of syphilis. The Wassermann reaction was negative, except for an insig-

[3] Vierteljahresschr. f. Derm. u. Syph. 8 (1881) 431.

[4] Cited in Scheube, Die Krankheiten der warmen Länder. Gustav Fischer, Jena (1910) 228.

[5] Proc. Roy. Soc. Med. Sec. Trop. Dis. & Parasitol. London 16 (1922–1923) 15.

[6] Sellards, A. W., and E. W. Goodpasture, Philip. Journ. Sci. 22 (1923) 233.

nificant trace of inhibition in one case. The general results obtained by us are given in Table 1.

The Wassermann reactions in this paper are recorded as follows:

+, almost complete hæmolysis.
++, about 50 per cent hæmolysis.
+++, about 75 per cent inhibition.
++++, complete or almost complete inhibition of hæmolysis.

TABLE 1.—*Superinfection in yaws.*

Serial letter.	First inoculation.					
	Date of first inoculation.	Character of lesion.	Date of appearance.	Incubation period.	*Treponema pertenue.*	Wassermann reaction before inoculation.
	1925			*Weeks.*		
A	January 17	Granuloma	February 14	3.5	+	—
B	do	do	do	3.5	+	—
C	do	do	February 17	4	+	±
D	do	do	February 21	4	+	+
E	do	do	February 17	4	+	—
F	do	Atypical				—

Serial letter.	Second inoculation.						
	Date of second inoculation.	Interval between first and second inoculations.	Character of lesion.	Date of appearance.	Incubation period.	*Treponema pertenue.*	Wassermann, March 21.
		Weeks.			*Weeks.*		
A	February 14	4	Granuloma	March 11	3.5	+	++
B	do	4	do	do	3.5	+	++
C	February 21	5	do	April 4	6	+	+
D	do	5	do	March 24	4.5	+	++
E	February 28	6	do	April 4	5	+	++
F	do	6	Negative				+

Serial letter.	Spontaneous secondary lesion.		
	Date of appearance.	Interval after first inoculation.	*Treponema pertenue.*
		Weeks.	
A	March 28	10	+
B	do	10	+
C	April 4	11	+
D	March 31	10.5	+
E	do	10.5	+
F	May 5	15.5	+

Material for the inoculation of these cases was taken from the granuloma that developed in the first patient reported in the preceding paper.[7] A fragment of tissue rich in treponemata was implanted in each of two incisions in the skin, made over the region of the deltoid. The incisions healed promptly, leaving a faint linear scar which showed no change until the tenth day after inoculation. At this time, both incisions in all six cases showed slight elevation of the epidermis and a slight degree of hyperæmia. Comparatively little change took place in the next few days. By the end of the third week after inoculation the lesions of the various patients began to show some minor individual variations. In case A the upper incision appeared as a ridge of epidermis, and the lesion on the lower incision, when examined with a hand lens, appeared slightly granulomatous. In four others (B, C, D, E) the lesions were definitely growing but the small zone of hyperæmia had disappeared in all but one (case C). Four days later a minute crust had begun to form in the center of the lesions of two of the cases (B and D) and in another (case E) the lesions were somewhat suspiciously granulomatous in character.

In the succeeding days the lesions rapidly took on a definitely granulomatous character; by the end of the fourth week after inoculation all of the first five patients showed a small granuloma at at least one of the two points of inoculation. By the end of the fifth week these five patients had developed definite granulomata at each of the two sites of inoculation. These increased rapidly, coalescing into one large yaw which continued to grow until treatment was commenced. In the sixth case (F) the lesions that appeared at the points of inoculation, instead of developing into granulomata, eventually regressed spontaneously.

From Table 1 it is evident that the exact time of appearance of the granulomata is stated somewhat arbitrarily. We have endeavored to note the earliest date at which the lesion would be recognized as a typical yaw by an observer entirely unfamiliar with the experimental record of these patients. Obviously the first clinical change occurred much earlier than the incubation period given for the appearance of the granulomata. No attempt was made to determine the earliest date at which treponemata could be recovered from the site of inoculation. For the study of superinfection the clinical picture is of im-

[7] Antea, 453–461.

portance, and we did not wish to disturb the character of the lesion by the manipulation necessary in securing tissue for microscopic examination.

The Wassermann test gave either weak or moderately strong reactions about two months after the first inoculation. Its titer then increased rather rapidly. Full details are given in a later paper.[8]

REINOCULATIONS

Two of these patients (A and B) were reinoculated at the end of the fourth week after the first inoculation, two others (C and D) at the end of the fifth week, and the remaining two (E and F) at the end of the sixth week. For the first five cases autoinoculations were made, by implanting a fragment of the primary yaw in a skin incision on the same arm about 3 centimeters below the mother yaw, and also in another incision over the deltoid, together with a control incision, on the opposite arm. The sixth case, in whom no yaw developed, was inoculated with tissue from patient E.

Following reinoculation the first five patients developed clinical manifestations essentially identical with those following the first inoculation in these cases. The lesion began with a slight elevation of the epidermis accompanied by hyperæmia. In four of these five cases (A, B, C, D), this change appeared very promptly, developing within four to seven days after the reinoculation, whereas after the first inoculation an interval of ten days elapsed before any change was noted. A granulomatous lesion developed at the site of at least one of the two points of reinoculation in each of these five patients. In some, the reinoculation made near the primary yaw was "lost" by coalescence with the mother yaw. The incubation period for the development of typical granulomata, though somewhat irregular, was not strikingly different from the incubation time following the first inoculation. Table 2 shows the character and location of the typical granulomata that had developed as a result of superinfection at the time when treatment was commenced.

The two patients (A and B) who were reinoculated four weeks after the first inoculation were kept under observation for an additional period of six weeks before treatment was commenced. The lesions of these two patients are illustrated in Plates 1 and 2. In Plate 2, fig. 2, is seen a small connecting ridge of granulomatous tissue between the smaller yaw and the primary yaw.

[8] Postea, 483–496.

TABLE 2.—*Location and character of lesions following reinoculation of yaws patients.*

Serial letter.	Reinoculation on the same arm near primary yaw.	Reinoculation on the opposite arm.
A	Granuloma coalescing with primary yaw	Small granuloma.
B	Typical granuloma	Small papule.
C	Small papule	Minute granuloma.
D	Granuloma coalescing with primary yaw	Small granuloma.
E	Cluster papules	Typical granuloma.
F	Negative	Negative.

The lower yaw developed at the site of reinoculation independently of the mother yaw. This ridge of granulomatous tissue developed by extension from the lower yaw upward to the mother yaw and made its appearance three or four days before this photograph was taken.

The illustrations of patients C, D, and E are shown in Plates 3, 4, and 5. Treatment of these cases was commenced at the end of eleven weeks after the first inoculation. The granulomata in case C developed typically but rather slowly. The reinoculation just below the primary yaw developed into a minute granulomatous lesion from which typical treponemata were demonstrated. This lesion showed no signs of regression at the time treatment was commenced. Two illustrations are given of the abortive lesions developing in patient E (Plate 6).

In the sixth patient (F) of this group the lesion behaved in an unusual manner. Following the original inoculation a slight elevation of the incisions occurred accompanied by hyperæmia, as in the other five cases. We were therefore completely surprised by the failure of these lesions to develop into typical yaws. Indeed, in this patient, ten days after inoculation, there was a distinct nodule in the middle of each of the two skin incisions corresponding to the site of implantation of the fragment of tissue, the ends of the incision showing only a barely discernible scar. Four weeks after inoculation this nodule had regressed, leaving a white area surrounded by a pink areola. Eleven days later it was noted that the pink areola around the central white area was in turn limited by a narrow white zone. The total diameter of the affected area measured 27 millimeters. From this time on, the areola of hyperæmia gradually faded, becoming white and rough. By the end of the eighth week it had disappeared without any frank desquamation. As already noted, the reinoculation in this patient gave entirely negative results.

Eleven weeks after inoculation, the Wassermann reaction in this patient gave a positive result (++). The superficial lymphatic glands were enlarged. There was an unusual macular lesion in the palms of both hands. This will be fully described in one of the following papers, on atypical clinical lesions of yaws.[9] A few small papules were present in the hairy part of the neck. Examination of these papules by dark field showed typical treponemata. The infection was terminated at this stage by treatment with neosalvarsan.

A generalized infection with yaws without the development of a primary lesion is of more than passing interest. Charlouis [10] inoculated thirty-two normal men with yaws, and twenty-eight became infected, a typical primary yaw appearing in each of the twenty-eight at the site of inoculation.

Nicholls [11] inoculated eight men successfully, but in three no primary yaw developed.

Paulet [12] reported that, of fourteen men successfully infected with yaws, only ten showed a local lesion. Powell, [13] as the result of careful clinical observations, noted that, in contrast to the majority of clinical records, about 20 per cent of two hundred five patients showed no primary lesion. The observations of Paulet and of Nicholls are usually quoted without emphasis or comment, the tenor of the literature leaning toward the view that yaws, at least as it occurs spontaneously, is regularly initiated by the development of a primary lesion.

The case we have described differs distinctly from the observations of Powell, and apparently also from those of Paulet and of Nicholls. Instead of no reaction, a very definite, though atypical, primary lesion developed at the site of inoculation, and then spontaneous regression occurred without the formation of a granuloma. Subsequently, a typical secondary eruption appeared. The original reports of Paulet and of Powell are not available here; it is possible that these authors reported only typical granulomata developing at the site of inoculation, and omitted any mention of atypical lesions.

[9] Postea, 475–481.

[10] Vierteljahresschr. f. Derm. u. Syph. 8 (1881) 431.

[11] A Report on yaws in Tobago, Grenada, 1894. Cited in Brit. Med. Journ. 2 (1901) 797.

[12] Arch. Gen. Med. 17 (1848) 385. Cited in Brit. Med. Journ. 2 (1901) 797.

[13] Proc. Roy. Soc. Med. Sec. Trop. Dis. & Parasitol. London 16 (1922–1923) 15.

218657——6

SECONDARY LESIONS

The date of the appearance of secondary lesions in these cases is of interest. In the two cases (A and B) reinoculated four weeks after the first inoculation, the spontaneous secondary lesions developed distinctly later than did those appearing at the site of reinoculation. Of the two patients, reinoculated at the end of the fifth week, the secondary granulomata were noted in one (C) simultaneously with the development of the autoinoculation; in the other patient (D) the secondary lesions were not recognized as definite granulomata until one week after the autoinoculation was recorded as a typical yaw. Of the two patients reinoculated at the end of the sixth week one remained negative (F), but the other (E) showed a typical granuloma; however, this did not develop until several days after the spontaneous appearance of several secondary granulomata. This suggests that secondary dissemination of the treponemata had already taken place at the time the autoinoculation was performed.

The primary and secondary granulomata were essentially similar in character in all of these cases. In a typical example the primary yaw was sharply outlined, measuring 2 by 3 centimeters, with an elevation of 3 to 4 millimeters above the surface of the skin. It was of a reddish color and was composed of confluent efflorescences, thus giving it a lobular appearance resembling the surface of a raspberry. In some areas the surface of the lesion shows irregular superficial erosion, and in others it is covered with a dry yellowish crust. Such a granuloma bears no resemblance to the usual textbook description of the typical primary ulcer of yaws. It is indeed curious that the very significance of the word "frambœsia" has been so completely lost that the typical primary lesion is described, not as a raspberrylike growth, but as an undermined ulcer. Ulceration is not a characteristic of the primary yaw, but can be brought about through secondary infection. Hallenberger [14] observed many cases of yaws in Africa and noted frequent secondary infection and ulceration of the granulomata. He proved experimentally, however, that the primary lesion is a granuloma and not an ulcer by inoculating yaws in some normal men and protecting the site of inoculation from secondary infection by a dressing. A typical granuloma developed.

[14] Beih. z. Archiv f. Schiffs- u. Tropenhyg. (1916–1920) 5.

Some confusion exists concerning the question of adenitis in yaws. The superficial lymph glands are much enlarged. Thus, Moss and Bigelow [15] noted that the epitrochlear glands were palpable in 58 per cent of eight hundred eighty-six cases of yaws in various stages. The femorals were found enlarged in 100 per cent of one hundred twenty-one cases. Clinical interpretation, however, is often complicated by the frequent occurrence of various infections in yaws patients which might explain the enlargement of the glands.

In all of the six cases that we studied, the axillary glands on the side on which the inoculation was performed became palpable during the sixth or seventh week after inoculation. Subsequently, many of the other superficial glands became either moderately or grossly enlarged in a typically indolent manner. The distribution of the affected glands is shown in Table 3.

TABLE 3.—*Enlargement of lymphatic glands.*

Serial letter.	Posterior auricular.		Cervical chain.		Axillary.		Inguinal.	
	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.
A	+	—	—	—	+	+	—	—
B	—	—	—	—	+	+	—	—
C	+	—	—	+	+	+	+	+
D	+	+	—	+	+	+	+	—
E	—	—	+	—	+	+	+	—
F	+	+	—	—	+	+	—	+

In these patients there was a moderate degree of generalized lymphadenitis resulting from the systemic distribution of the treponemata, but the glands most noticeably enlarged were those draining the areas where granulomata had developed. The involvement of the lymph glands was more extensive than that ordinarily found in syphilis. The epitrochlear glands were enlarged in the patient (E) showing palmar lesions; of the other five patients, none had any lesions on the hands or forearms, and only one showed enlargement of the epitrochlear glands. Moreover, upon treatment these enlarged glands subsided very slowly. In a general way, by the time the granulomata had disappeared the enlarged glands had diminished about one-half in size.

[15] Bull. Johns Hopkins Hosp. 33 (1922) 43.

The temperature of these patients was taken daily, in the afternoon, throughout the entire course of this work. No febrile reactions whatever occurred, except in one patient who developed a slight intercurrent infection which lasted only a few days.

DISCUSSION

It has not yet been possible to determine finally whether some degree of active immunity develops in yaws, or whether resistance to reinfection is due to the persistence of a low-grade infection. We have shown however that, in contrast to syphilis, superinfection in yaws is possible, even after the typical primary granuloma has developed.

Six volunteers were inoculated with yaws. Five developed a typical granuloma at the site of inoculation. On reinoculation of these five patients, a lesion developed at the site of reinoculation which, clinically, was of a granulomatous character, and treponemata were found on microscopic examination.

The sixth patient of this group showed only an abortive reaction at the site of the first inoculation, but subsequently a secondary eruption appeared.

The primary efflorescence in yaws, as in syphilis, is a papule. Whereas in syphilis the papule progresses into an irregular, sharply punched-out ulcer, in yaws it develops into an oozing granuloma which becomes covered by an amberlike crust.

ILLUSTRATIONS

Plate 1. Patient A

Fig. 1. Two primary granulomata, four weeks after inoculation.

2. The same as fig. 1, six weeks later, including an area of superinfection at the lower pole, coalescing with the primary lesion, ten weeks after the first inoculation.
3. Superinfection on the opposite arm, six weeks after a reinoculation performed four weeks after the first inoculation.

Plate 2. Case B

Fig. 1. Two primary lesions, four weeks after inoculation. The granulomatous character of these lesions was unmistakable, but this is not clearly shown in the illustration.

2. The same as fig. 1, six weeks later, showing coalescence into one large granuloma (ten weeks after the first inoculation). Below this is a smaller granuloma produced by reinoculation performed four weeks after the first inoculation.

Plate 3. Case C

Fig. 1. Two primary granulomata, four weeks after inoculation.

2. The same as fig. 1, one week later, at the time of reinoculation.
3. The same as fig. 1, six weeks later, showing coalescence into one large granuloma (eleven weeks after the first inoculation). Just below this is one minute granulomatous lesion developing at the site of a reinoculation performed five weeks after the first inoculation.
4. Spontaneous secondary yaw in the right axilla at the end of eleven weeks after the first inoculation.

Plate 4. Case D

Fig. 1. Two primary granulomata, four weeks after inoculation.

2. The same as fig. 1, one week later, at the time of reinoculation.
3. The same as fig. 1, six weeks later (eleven weeks after the first inoculation).
4. Superinfection on opposite arm, six weeks after reinoculation performed five weeks after the first inoculation.

Figs. 5 and 6. Spontaneous secondary granulomata, eleven weeks after the first inoculation.

Plate 5. Case E

Fig. 1. Two primary granulomata, four weeks after inoculation.

2. The same as fig. 1, two weeks later, at the time of reinoculation.
3. The same as fig. 1, five weeks later (eleven weeks after the first inoculation).

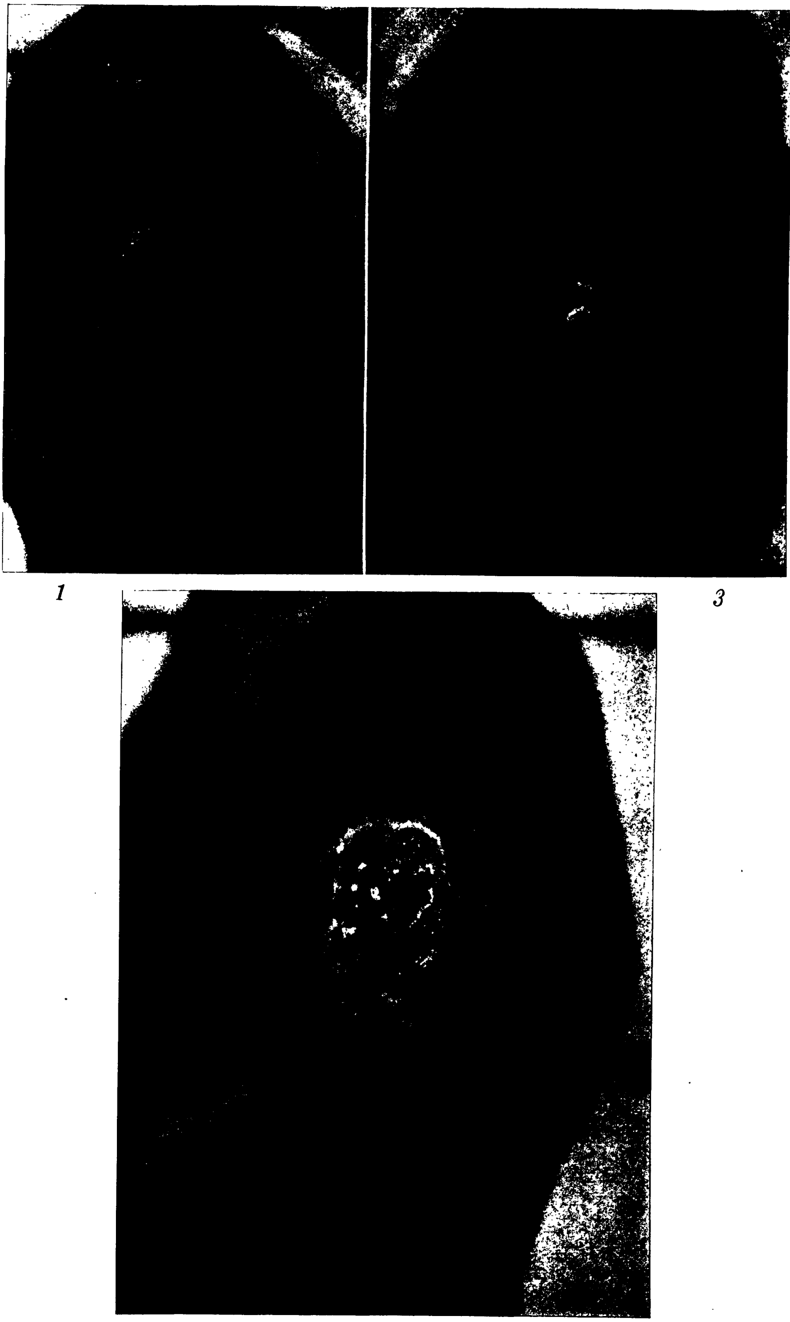
FIG. 4. Superinfection on the opposite arm, five weeks after reinoculation performed six weeks after the first inoculation.

5. Spontaneous granuloma, eleven weeks after the first inoculation.

PLATE 6. CASE E.

FIG. 1. Two primary lesions, four weeks after inoculation.

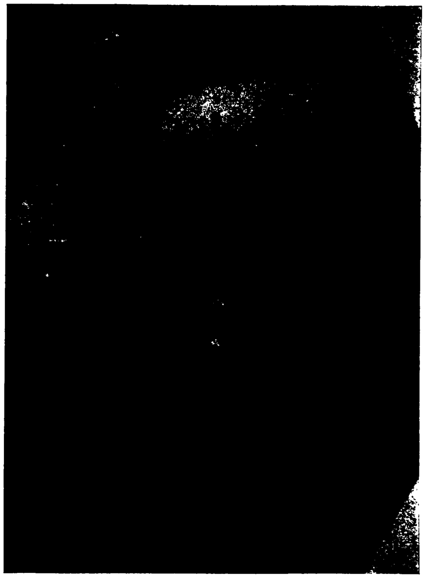
2. The same as fig. 1, two weeks later, shortly before spontaneous regression. These lesions are rough, but not elevated.



1 3

2

PLATE I



1

2

PLATE 2.

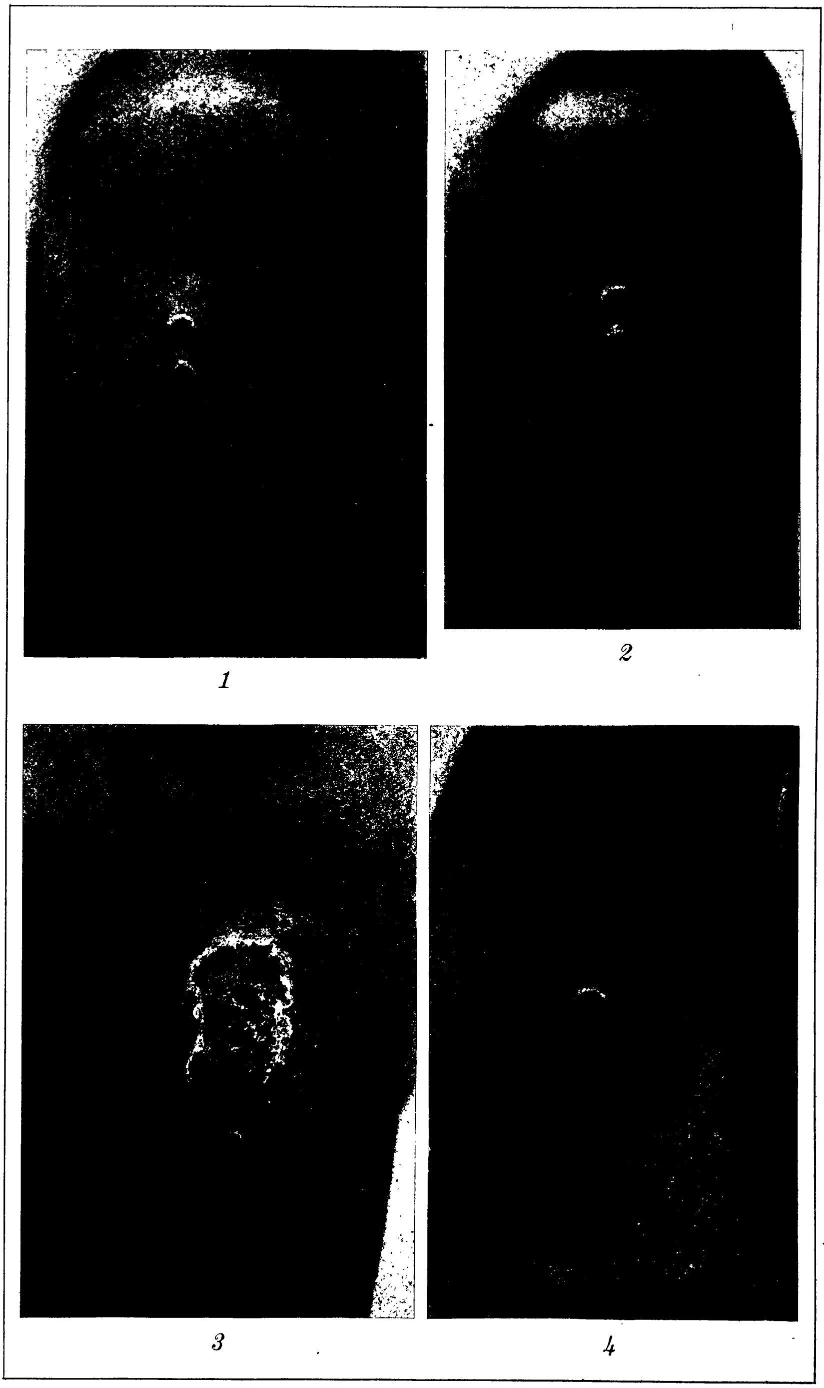


PLATE 3.

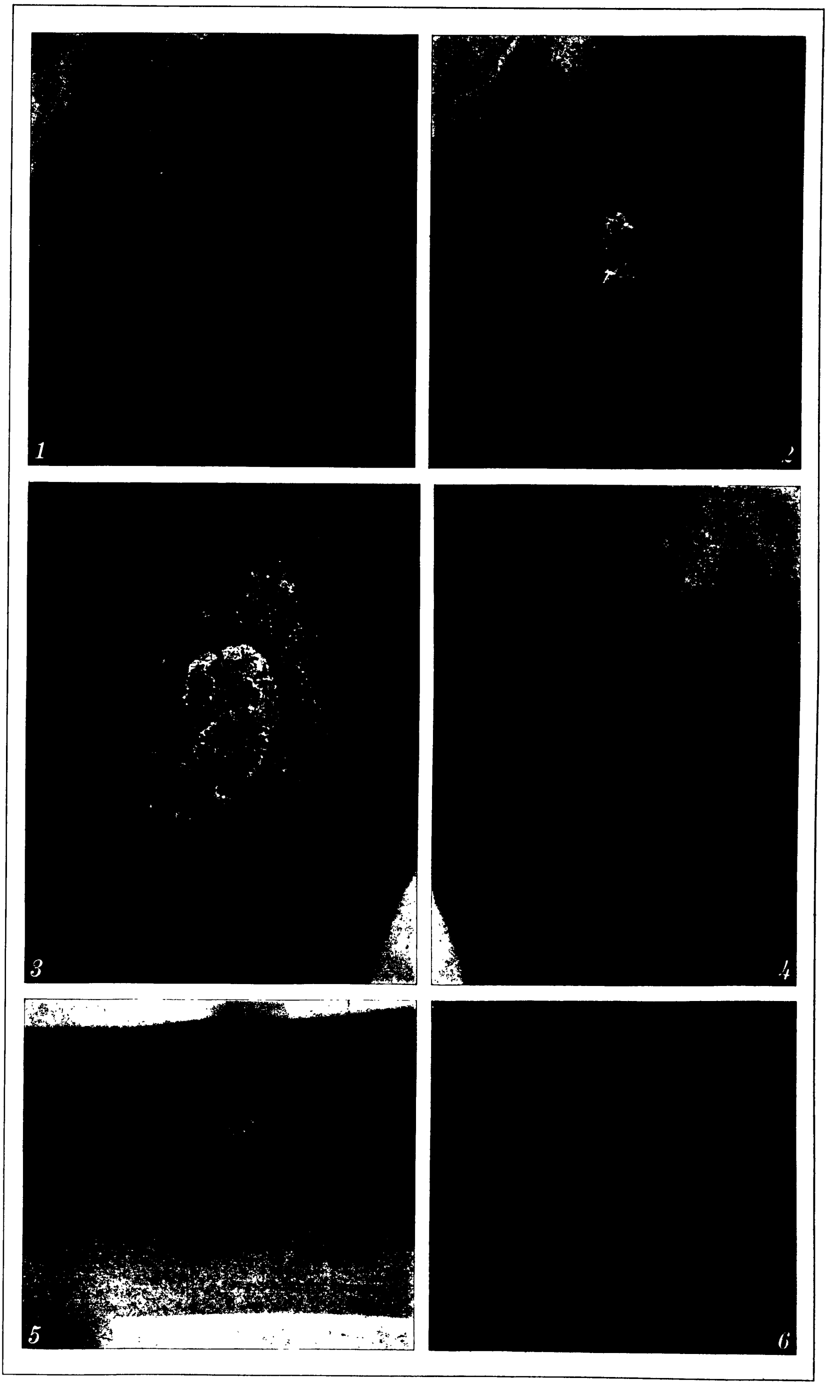


PLATE 4.

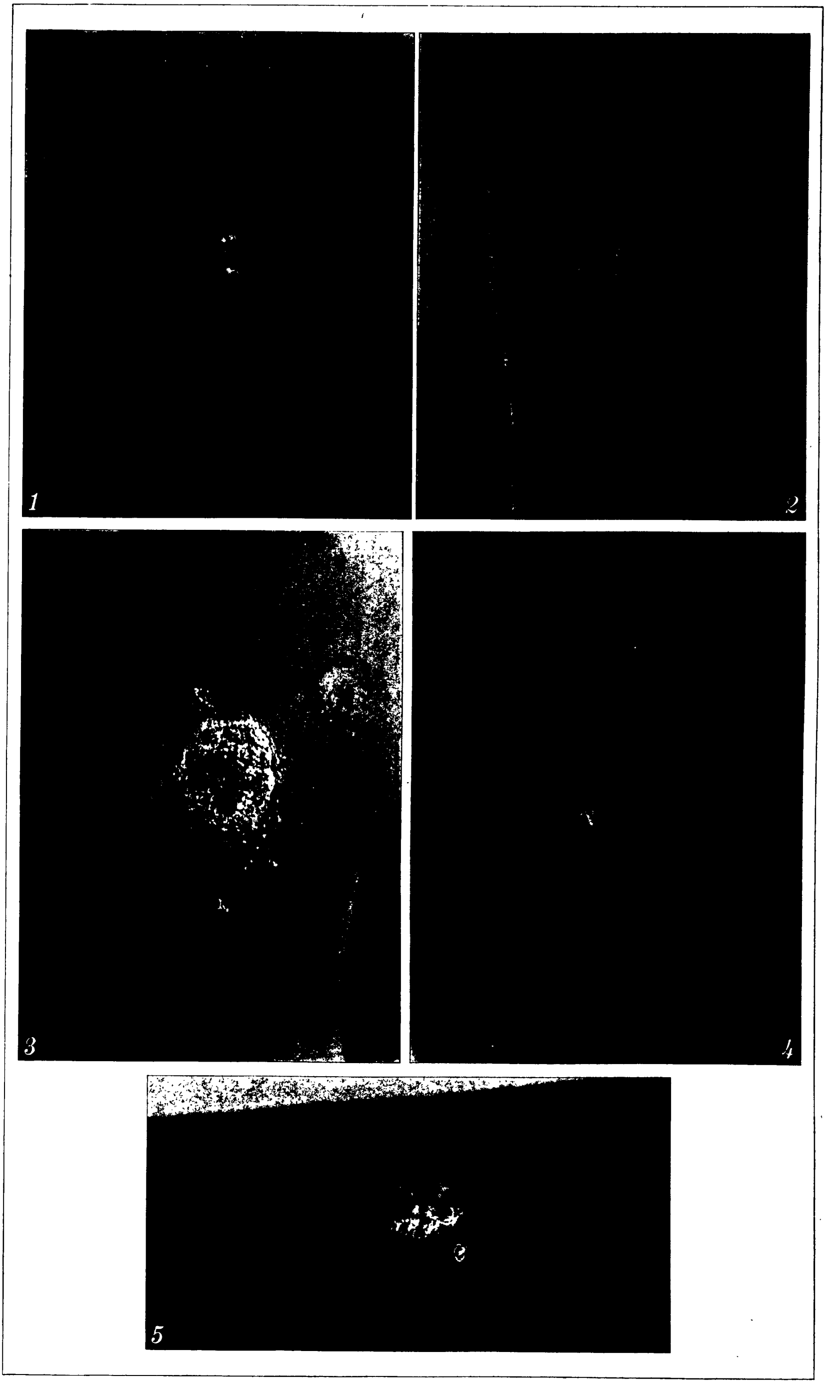
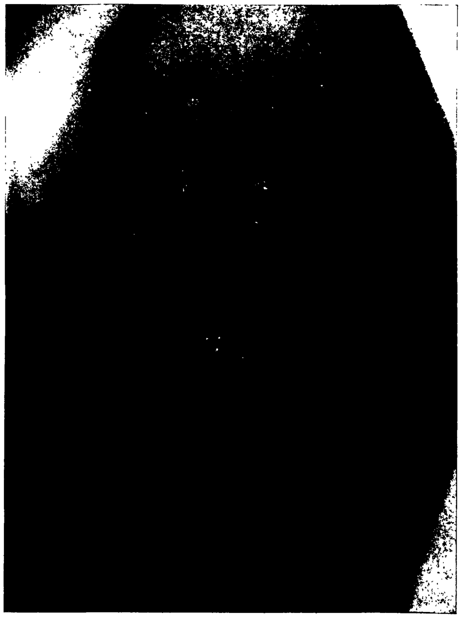
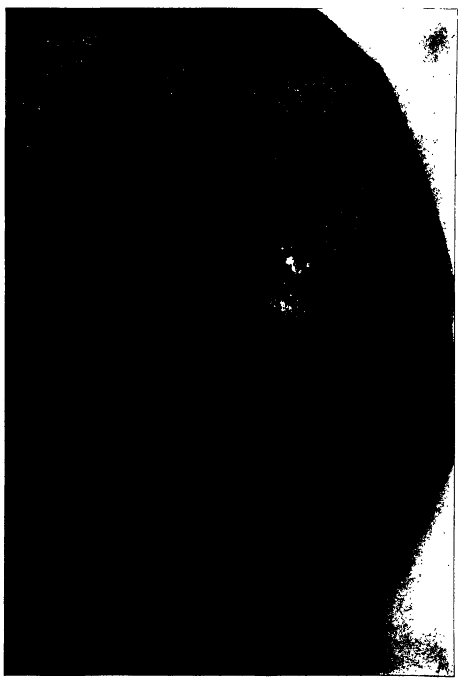


PLATE 5.



1



2

PLATE 6.

SOME PROTEAN MANIFESTATIONS OF THE SKIN LESIONS OF YAWS [1]

By Otto Schöbl
Of the Division of Biology and Serum Laboratory, Bureau of Science

Andrew Watson Sellards
Of the Harvard Medical School, Department of Tropical Medicine, and the Bureau of Science

and

George Rufus Lacy
Of the International Health Board and the Bureau of Science

THREE PLATES

When comparison is made between syphilis and yaws it is customary to emphasize the protean nature of the clinical manifestations of syphilis and the almost monotonous uniformity of the lesions of yaws. During the course of the work on the inoculation of yaws in man [2] some unusual clinical features were observed. Under the conditions of experimental control it was possible to determine definitely that these lesions were due to yaws, though under ordinary conditions the interpretation of some of them would have been difficult or impossible. In the following descriptions it will be necessary to refer to some of the cases and illustrations discussed in the preceding papers on immunity and on superinfection.[3]

Three types of atypical lesions were observed; namely, a lichenoid eruption surrounding the point of inoculation or reinoculation; a circular exfoliative maculo-squamous exanthem on the palms; and a keratoid exanthem of the trunk and extremities.

The most striking illustration of the first type of lesion was observed in patient 4, a treated case of yaws who was inoculated again with yaws two years after his last treatment. The illustration (Plate 1, fig. 3)[3] shows the lesion at the height

[1] From the Bureau of Science, Manila.

[2] Antea, 463–474.

[3] The cases and illustrations discussed in the following six paragraphs are reported in antea, 453–461, and 463–474.

of its development. As previously noted, the small oval area of normal skin can be observed, the center of which represents the point of reinoculation. This normal area is surrounded by multiple efflorescences; these are discrete, but show a tendency to concentric grouping toward the center, while on the periphery they radiate into the normal skin. The individual efflorescences are acuminated papules with a narrow base and a silvery white glistening summit. The coalescence of the efflorescences produces clusters with more-extensive, scalelike surface. There is no exfoliation of the scaly glistening surface of the efflorescence. The scale can be removed easily and its base does not bleed, as in psoriasis. The efflorescences are distinctly of lichenoid character in as much as, from the beginning to the end, they persist as papules, but the scaling of the summit is more pronounced than in lichen planus and the summit is only slightly flattened and not umbilicated. By coalescence, clusters of considerable size are produced, but the individual efflorescences are distinctly discernible in the clusters and do not coalesce into large confluent patches. This lesion disappeared spontaneously without leaving any area of pigmentation—a feature which occurs commonly after the healing of an ordinary granuloma.

A less-striking example of this lesion occurred under similar circumstances; namely, in patient 3, a treated case of yaws, who was reinoculated three years after treatment.

Another treated patient (No. 1) upon reinoculation developed a typical granuloma which, however, grew slowly and later was surrounded by white efflorescences similar to those just described (Plate 1, fig. 2).[3] At first glance we saw nothing in this lesion in any way suggestive of yaws. Yet, by mere exclusion, it seemed necessary to accept the interpretation that this lesion was in some unexplained way the result of the reinoculation.

Subsequently, something of a connecting link was observed between these skin lesions and others of a somewhat similar nature which occurred in two of the normal persons inoculated with yaws. One of these is the patient F (Plate 6, fig. 2)[3] who failed to develop a primary yaw. In the other, D (Plate 4, fig. 3),[3] a typical granuloma appeared at the site of inoculation. This was seen surrounded by several small red papules which enlarged and coalesced with the mother yaw. Then additional papules appeared which soon became dry and white.

Three of the patients (3, 4, and F) in whom these lesions occurred failed entirely to develop granulomata at the site of inoculation with *Treponema pertenue;* in two others (A and 1),

efflorescences developed around primary granulomata that had reached their maximum limit of development. It is possible that these lesions may be associated in some measure with an increase in the patient's resistance to infection.

The lesions of the palms (Plates 1 and 2) appeared almost simultaneously with the secondary eruption of yaws. They were restricted to the palms and to the flexor surface of the fingers and the wrist. They were multiple and somewhat symmetric, measuring from 0.5 to 2 centimeters in diameter. They appeared in rapidly successive crops. The primary efflorescence was a flat macule of copper color on the almost white skin of the palm in a half-caste. The larger macules showed a central circular exfoliation. The margin of the exfoliated area was formed by a paper-white undermined epidermis. The base of the exfoliated area was dry, reddish, and slightly indurated, and showed moderate secondary exfoliation. The exfoliation progressed proportionately to the spread of the original macule. Consequently, the largest lesions presented chiefly exfoliated areas outlined by a dark red, slightly raised margin, representing the remains of the original macule. Treatment with neosalvarsan caused prompt disappearance of these lesions.

Of all the skin diseases restricted to the palm, the only one that deserves serious consideration, from the standpoint of differential diagnosis, is syphiloderma manus. The dermatologic picture of the lesions in the palms of this case of yaws remarkably resembles that described and illustrated as syphiloderma manus by Fox.[4] Only by virtue of the experimental conditions, which excluded hereditary and acquired syphilis beyond doubt, were we in a position to decide definitely that the lesions on the palms of this case were of frambœsial origin.

At a later date, with Dr. Lopez-Rizal, we examined thirty-three cases of yaws in Mountain Province,[5] in a district where syphilis is so rare that its presence has not yet been definitely established. Two of these cases showed palmar lesions very similar to those in this experimental case.

It would be interesting to observe the course of this palmar frambœside without treatment. It can hardly be the usual forerunner of the classical case of "clavos." We have seen the various stages in the development of clavos, beginning with typical multiple granulomata in the palms of the hands or the

[4] Photographic Atlas of the Diseases of the Skin. J. B. Lippincott Co., Philadelphia and London (1904).

[5] Postea, 497–505.

soles of the feet. Subsequently the surrounding epidermis becomes greatly thickened and exfoliates, while the original granulomata dry up, leaving a hard center like a nail, and this eventually falls out, leaving a "nail-hole." Thus in Spanish-speaking countries the condition received the name of "clavos." On the other hand, cases of clavos are extremely common, in which only greatly thickened layers of exfoliating epidermis are seen with no trace whatever of the original granulomata. It is quite conceivable that some of these cases may have originated merely as a frambœside without any development of granulomata.

A beautiful illustration occurred in one patient (No. 1) [6] of what may be called keratoid exanthem of the trunk and extremities. This patient, it will be recalled, had been reinoculated more than two years after his last treatment for yaws. A primary yaw developed promptly and, six months later, secondary granulomata appeared on the scalp. The rest of the body was almost free from granulomata, but over the back and on the chest and the extremities there was an abundant exanthem (Plate 3). The eruption was sparse over the abdomen and on the arms and legs; it was most marked over the extensor surfaces. The lesions were circinate, varying in diameter from 1 to 3 centimeters, and they were slightly hyperæmic at the margin. They were rough on palpation and were rendered prominent to the eye by the very distinct, white papillæ that stood erect like goose flesh. This effect became more pronounced when a physiological goose flesh was induced by exposure of the patient's body to a cool breeze. The individual efflorescences of which such macular lesions are composed remind one of keratosis pilaris. As in keratosis pilaris, they are numerous and are small, conical, follicular papules of white color located over the trunk and the extensor surfaces of the extremities. In the case under discussion there was no itching, but the depigmentation of the entire area, which involved the hair of the skin, was much more pronounced than in keratosis pilaris. There was no desquamation and the lesions were not diffuse, but were arranged in multiple, distinct, sharply outlined patches.

According to Schüffner,[7] macular depigmented exanthems are not infrequent among the natives of Sumatra. Schüffner con-

[6] Antea, 456.

[7] Münchener Med. Wochenschr. 54^2 (July–December, 1907) 1366.

siders them pathognomonic for yaws and remarks that these exanthems are well known as manifestation of yaws to the natives of Sumatra, who call them *bunga puru* (the blossoms of yaws). Schüffner further states that, with the possible exception of Fournier's "syphilide papuleuse ponctuée," no such exanthem exists in syphilis.

Baermann [8] describes and illustrates a similar condition as a chronic, rather rare, pathologic lesion of the skin. The similarity of the general character of this lesion to other atypical lesions leads him to believe that there is no doubt as to the etiology of the exanthem, although he was unable to demonstrate *Treponema* in these lesions. Baermann's clinical observation is confirmed by our experimental evidence.

Gutierrez,[9] under the heading of "macular lesions," describes skin manifestations in yaws similar to the palmar maculo-squamous changes and the keratoid efflorescences that we noted. He believes these lesions to be framboesial, but says: "Those who have studied the disease do not always accede the occurrence of this type of eruption." This statement clearly indicates a disagreement among frambœsologists as to the etiologic classification of these cutaneous manifestations. Consequent to our observation there is no longer doubt that these lesions are frambœsides, or that the exanthems described by Schüffner, by Baermann, and by Gutierrez belong to the same group of independent secondary frambœsides and are identical with the one observed by us.

Under treatment with neosalvarsan the granulomata disappeared promptly in our patient, but traces of the exanthem were still present three weeks after the second injection of neosalvarsan. This slow disappearance is not surprising when we remember that the exanthem was characterized by loss of pigment—a character common to all frambœsides accompanied by loss of pigment.

DISCUSSION

One of the striking features of *Treponema pallidum* is the great variety of clinical manifestations that it produces. In striking contrast, *Treponema pertenue* is usually considered as producing remarkably uniform lesions, having lost or else never having acquired such versatility.

[8] Beihefte z. Arch. f. Schiffs- u. Tropenhyg. 15 (1911) 5.

[9] Arch. Dermat. & Syph. 6 (1922) figs. 13 and 14.

In this paper, however, we have emphasized that in the skin manifestations of yaws there are, in addition to the typical granuloma, at least three other types of exanthem, distinct in themselves rather than representing different stages of one and the same lesion. The skin manifestations of *T. pertenue* are almost as varied as are those produced by *T. pallidum.*

All of the three atypical lesions herein described were observed in experimental cases whereby their etiology was definitely determined.

ILLUSTRATIONS

PLATE I.

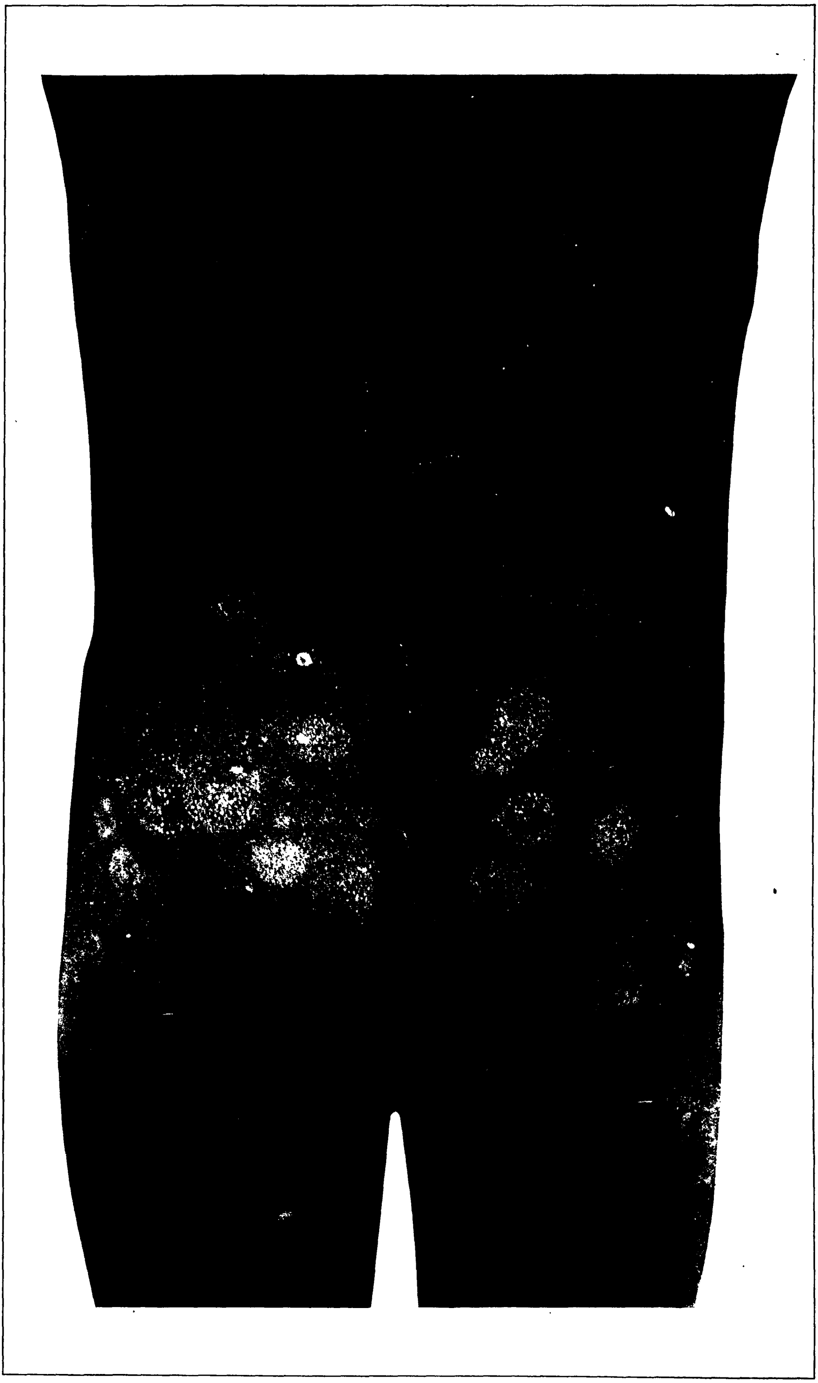


PLATE 3.

THE GLOBULIN PRECIPITATION REACTION IN YAWS

ITS INDEPENDENCE OF THE WASSERMANN REACTION AND ITS BEHAVIOR DURING THE COURSE AND TREATMENT OF THE DISEASE

By Otto Schöbl and José Ramirez

Of the Division of Biology and Serum Laboratory, Bureau of Science, Manila

INTRODUCTION

The findings resulting from the application of the globulin precipitation test to the sera of lepers have been reported in a previous paper.[1] In brief, this test depends on the precipitation of globulin in a patient's serum upon dilution with distilled water. The principle involved in this reaction is the same as that involved in the reaction of Klausner,[2] but the factor of low temperature and the quantitative estimation of the serum have been introduced by us.

Simultaneously with the globulin precipitation test, the Wassermann test was carried out. It was found that in all forms of leprosy (macular, tubercular, neural, or mixed), treated or untreated, the globulin precipitation reaction was positive in all cases tested. While the degree of this reaction varied in individual cases, there was found an indication that among the treated lepers, the arrested cases (that is to say, microscopically and clinically negative) usually gave less-pronounced reaction than did the active cases, treated or untreated. Perfectly healthy normal individuals, of the same race, showed negative results up to the dilution with distilled water of their sera in the proportion of one part of serum to three parts of distilled water. In higher dilutions than 1: 3, the sera gave positive results in certain cases of healthy persons. Therefore, the dilution 1: 3 was taken as the normal limit, in as much as none of the sera of healthy persons tested gave any precipitation at that dilution. On the part of the cured lepers the reaction of globulin precipitation approached this normal limit to a certain extent, although all of them showed more or less pronounced precipitation in the 1: 3 dilution. It became further

[1] Schöbl, Otto, and M. Basaca, Philip. Journ. Sci. 25 (1924) 1–9.

[2] Wiener Klin. Wochenschr. 21 (1908) 214, 363, and 940.

evident that there was no relation between the results of this test and those of the Wassermann test, performed with the same lepers' sera. This observation led us to believe that no relation exists between globulin precipitation and the Wassermann test in leprosy. It remained, however, to show further that this independence of the two reactions is true generally and not only in leprosy and, if possible, to demonstrate experimentally that the protein substance precipitable by dilution of serum with distilled water is different from that which carries the Wassermann antibody.

In the paper cited above [1] there were included in the test a few sera obtained from patients suffering with beriberi, yaws, syphilis, or afebrile tuberculosis. Of these various diseases, the precipitation was most pronounced with the serum from a patient who had suffered from active yaws, in whom the clinical manifestations had disappeared under treatment with neosalvarsan. Indeed, the reaction was more pronounced than any that had occurred in the previous examinations. This result led us to undertake a further investigation in respect to yaws, and it was hoped that parallel tests by the globulin precipitation and the Wassermann reactions would give further information as to whether the globulin precipitation and the Wassermann tests are dependent upon the presence of the same substance in the serum or whether they are independent of each other. The Wassermann reaction, as is well known, is strongly pronounced in cases of yaws, particularly active ones. The result obtained with one patient's serum by globulin precipitation reaction suggested that this reaction may be also generally positive in yaws.

As mentioned in the paper by Schöbl and Basaca, [3] the globulin precipitation test must be considered as a nonspecific reaction. Nevertheless, even though the reaction be evidently positive in several diseases, its value as an adjuvant method need not be underestimated. We may consider the investigation of a patient's serum, by various serological methods, as a general serological analysis, analogous to the general urine analysis. If we carry the comparison through, we should place this and other nonspecific serologic reactions in the same group of tests with the examination of the urine for albumin. The presence of albumin in the urine in itself does not necessarily indicate

[3] Philip. Journ. Sci. 25 (1924) 1–9.

nephritis or any other particular disease resulting in albuminuria; yet no one will deny the value of this test for albumin in a given case. Neither does a positive Wassermann reaction necessarily indicate that the patient suffers from syphilis.

THE GLOBULIN PRECIPITATION REACTION IN YAWS AND ITS INDEPENDENCE OF THE WASSERMANN REACTION

In the course of our investigation we had the opportunity to test the sera of a series of active cases of yaws and also of a group of yaws patients treated three years previous to our investigation.[4]

As to the technic, we wish to emphasize that the blood was taken by means of a sterile syringe, and placed in sterile test tubes. After clotting, the serum was centrifuged free of cells and examined by the globulin precipitation test within five hours after the blood had been obtained. The technic described by Schöbl and Basaca [5] was strictly followed and the readings refer to actual precipitation encountered in the tubes that contained the stirred dilutions of serum and distilled water, were allowed to stand for two hours at room temperature (about 28° C.), and then kept overnight in the refrigerator (at between 6° and 9° C.). As far as the technic of the Wassermann reaction is concerned [6] the reagents and their amounts are evident from the tables.

A positive globulin precipitation test was found in each of twenty-four successive cases of active yaws. The Wassermann reaction is also constantly positive in secondary yaws. Therefore, patients after treatment offer greater possibility of variation for comparison of these two reactions. We therefore tested the serum of sixteen cases after treatment. From Tables 1, 2, and 3 we can see the disagreement, both qualitative and quantitative, between the globulin precipitation and the Wassermann reactions. Although some of the low-grade reactions as well as the high-grade reactions agree, there is a sufficient number of them that disagree. This appears to be further evidence of the independence in general of the two reactions, as already found in leprosy.[7]

[4] Sellards, A. W., et al., Philip. Journ. Sci. 22 (1923) 219–285.

[5] Philip. Journ. Sci. 25 (1924) 1–9.

[6] Schöbl, Otto, and Carlos Monserrat, Philip. Journ. Sci. § B 12 (1917) 249.

[7] Schöbl, Otto, and M. Basaca, Philip. Journ. Sci. 25 (1924) 1–9.

EXPLANATION OF SYMBOLS USED IN TABLES

Globulin precipitation test:
—, no precipitate.
±, faint precipitate.
+, distinct precipitate.

Wassermann reaction:
—, negative.
+, weakly positive.
++, moderately positive.
+++, strongly positive.

TABLE 5

Ratios at the head of the table indicate dilutions of equal amounts of patient's serum and increasing amounts of distilled water.

Fractions heading the Wassermann reaction columns indicate dilutions of complement.

Alc. ant., alcoholic antigen.

Chol. ant., cholesterinized alcoholic antigen.

Ser. con., serum control.

Dates at the head of the table indicate the days when blood was withdrawn from the patients.

Treatment once weekly was given to patients A and B, April 1 to April 22; to patients C, D, and E, April 7 to April 29; and to patient F, May 5 to May 12.

Lymphadenitis:
—, no glands palpable.
++, bilateral brachial or epitrochlear.
++++, multiple lymphadenitis.
0, not examined.

TABLE 1.—*Showing the results of the globulin precipitation reaction in active cases of yaws.*

No.	Name.	Age.	Dilution of serum with H_2O—				
			1 : 1	1 : 2	1 : 3	1 : 4	1 : 5
		Yrs.					
1	S. B.	9	—	—	+	+	+
2	B. H	8	—	—	+	+	+
3	R. S	10	—	+	+	+	+
4	E. A	8	+	+	+	+	+
5	B. G	10	—	+	+	+	+
6	E. L	50	—	—	+	+	+
7	P. P	6	—	+	+	+	+
8	N. Y	30	—	—	+	+	+

TABLE 2.—*Showing the results of the globulin test and the Wassermann reaction in active cases of yaws.*

No.	Name.	Age.	Globulin test, dilution of serum with H_2O—					Wassermann reaction.				Remarks.
								Alc. ant.		Chol. ant.		
			1:1	1:2	1:3	1:4	1:5	1/10	1/5	1/10	1/5	
		Yrs.										
9	E. P......	45	±	+	+	+	+	+	—	+	—	
10	A. G......	15	±	+	+	+	+	±	—	+	—	
11	C. E......	52	—	—	+	+	+	+	—	+++	—	
12	A. L......	13	—	+	+	+	+	±	—	+++	—	
13	I. S......	7	—	+	+	+	+	+	—	++	—	
14	P. L......	39	—	—	+	+	+	—	—	—	—	
15	Procta, L..	10	—	+	+	+	+	±	—	++	—	
.16	E. G......	6	—	+	+	+	+	+	—	+	—	
17	M. M	16	—	—	+	+	+	—	—	—	—	Suspected yaws.
18	B. C......	16	—	—	+	+	+	+	—	+++	—	
19	T. de la C..	14	—	±	+	+	+	+	—	+	—	
20	F. G......	11	—	+	+	+	+	++	—	++	—	
21	E. P......	70	—	—	+	+	+	+	—	++	—	
22	A. I......	12	±	+	+	+	+	+++	++	+++	++	See Table 4.
23	F. V......	13	—	+	+	+	+	++	—	+++	+	Do.
24	J. M......	8	—	+	+	+	+	+	—	++	—	Do.

To add experimental evidence to this observation we arranged the following experiment, the result of which is evident from Table 4.

Blood was collected from three active yaws patients—Antonio Iloya, 12 years; Fernando Vasquez, 13 years; and Julio Malopa, 8 years old.

Within five hours after the collection of the blood the globulin precipitation reaction was performed and the result read next morning. A distinct precipitate was noticed in 1:1 dilution of serum with distilled water and in all following dilutions in the case of Antonio Iloya, and distinct precipitate was found in all dilutions of the serum beginning with 1: 2 in the case of F. Vasquez and of J. Malopa. The dilution 1: 3 in the case of A. I. and of F. V., and the dilution 1: 2 in the case of J. M., were centrifugated and the precipitate packed at the bottom of the test tube. The clear supernatant fluid was carefully decanted and used for Wassermann reaction.

TABLE 3.—*Showing the results of the globulin test and the Wassermann reaction in treated cases of yaws.*

No.	Name.	Age.	Globulin test, dilution of serum with H_2O—					Wassermann reaction.				Remarks.
								Alc. ant.		Chol. ant.		
			1 : 1	1 : 2	1 : 3	1 : 4	1 : 5	1/10	1/5	1/10	1/5	
		Yrs.										
1	L. M.	12	—	—	—	±	+	—	—	—	—	(a)
2	F. P.	10	—	—	±	+	+	+	—	++	—	
3	F. M.	9	—	±	+	+	+	—	—	+	—	
4	L. R.	8	—	+	+	+	+	—	—	—	—	
5	C. S.	12	—	+	+	+	+	—	—	+	—	
6	G. S.	11	±	+	+	+	+	—	—	++	—	
7	E. G.	14	—	—	+	+	+	—	—	—	—	
8	D. de la I.	7	—	—	+	+	+	—	—	—	—	
9	J. B.	9	—	—	+	+	+	—	—	+	—	
10	P. de L.	7	—	±	+	+	+	+	—	++	—	
11	C. R.	9	—	+	+	+	+	—	—	—	—	
12	P. G.	13	—	—	+	+	+	±	—	+	—	
13	A. F.	8	—	—	±	+	+	—	—	—	—	(a)
14	L. E.	9	—	—	+	+	+	+	—	+	—	
15	B. F.	12	—	—	±	+	+	±	—	±	—	
16	L. L.	9	—	—	+	+	+	+	—	++	±	
17	R. de L.	8	—	—	±	+	+	±	—	+	—	
18	C. F.	8	—	—	±	+	+	±	—	+	—	
19	V. C.	8	—	—	+	+	+	++	—	++	±	

[a] Complete serologic cure.

TABLE 4.—*Showing the result of the Wassermann reaction with sera of yaws patients before and after the removal from the sera of the protein which precipitates on dilution with distilled water. Cholesterinized antigen and two units of amboceptor were used.*[a]

No.	Name.	Precipitated serum.		Unheated serum.		Heated serum.	
		1 : 10 [b]	1 : 5 [b]	1 : 10 [b]	1 : 5 [b]	1 : 10 [b]	1 : 5 [b]
22	A. I.	+++	++	+++	+++	+++	+++
23	F. V.	+++	+	+++	+	+++	+
24	J. M.	++	—	++	—	++	—

[a] See Table 2 for results of globulin precipitation test.
[b] Dilution of complement.

The Wassermann reaction was carried out in the following way: As soon as the patients' sera had separated they were decanted and centrifuged clear of red cells. Part of each serum was used for the globulin test and the remainder of the sera was stored in the refrigerator. Immediately before the Wassermann test was performed (that is to say, the morning after the day on which the blood was collected), half of each serum was

inactivated by heating at 56° C. for thirty minutes on the water bath; the other half of each serum was used without heating. In this way three samples of each patient's serum were examined simultaneously: Patients' unheated serum diluted with water and allowed to precipitate as described above; patients' unheated serum diluted correspondingly with distilled water immediately before the Wassermann test; and patients' inactivated serum treated in the same way diluted correspondingly with distilled water immediately before the Wassermann test was performed. Two units of amboceptor 1: 10 and 1: 5 dilution of complement were used. Further details of the experiment are evident from the table. All three of the sera gave positive results; one was very strong, one was moderately so, and one was weakly positive.

It has been clearly demonstrated by this experiment that there is no relation between the precipitable protein substance (that is, the substance that precipitates from the serum upon dilution with distilled water) and the substance that carries the Wassermann antibody. The result of the Wassermann reaction, both qualitatively and quantitatively, was the same with the sera, whether examined fresh, or heated for thirty minutes at 56° C., or whether supernatant fluid only was used for the Wassermann reaction. In other words, whether the globulin precipitated out of the serum by dilution with distilled water was removed from or retained in the patients' sera, the result of the Wassermann reaction was exactly the same.

THE GLOBULIN PRECIPITATION REACTION IN YAWS AND ITS BEHAVIOR DURING THE COURSE AND TREATMENT OF THE DISEASE AS COMPARED WITH THE WASSERMANN REACTION

The globulin precipitation reaction in yaws varies in degree in active as well as in healed cases. As an anamnestic reaction it appears to last longer than the Wassermann reaction, in which respect yaws resembles leprosy. The considerable differences in the strength of the globulin reaction, as encountered among individuals with active and healed yaws, cannot be explained unless the starting stage and the progress of the reaction are known in the course of the disease. In six patients (A, B, C, D, E, and F)[8] the globulin and the Wassermann reactions were tested at frequent intervals during the incubation period, at the height of the clinical symptoms, and after treatment with neosalvarsan. The results of the successive examina-

[8] Antea, 464 et seq.

tions by the globulin and the Wassermann reactions are given in Table 5.

TABLE 5.—*Showing the progress of globulin precipitation and the Wassermann reaction in yaws during the course and treatment of the disease.*

Name.[a]	January 17.									
	Globulin precipitation reaction.					Wassermann reaction.				
	1:1	1:2	1:3	1:4	1:5	Alc. ant. 1/5	Alc. ant. 1/10	Ser. con. 1/10	Chol. ant. 1/5	Chol. ant. 1/10
A	—	—	±	+	+	—	—	—	—	—
B	—	—	±	+	+	—	—	—	—	—
C	—	—	—	+	+	—	—	—	—	±
D	—	—	±	+	+	—	—	—	—	—
E	—	—	—	+	+	—	—	—	—	—
F	—	—	±	+	+	—	—	—	—	—

Name.[a]	February 14.									
	Globulin precipitation reaction.					Wassermann reaction.				
	1:1	1:2	1:3	1:4	1:5	Alc. ant. 1/5	Alc. ant. 1/10	Ser. con. 1/10	Chol. ant. 1/5	Chol. ant. 1/10
A	—	±	+	+	+	—	—	—	—	—
B	—	+	+	+	+	—	—	—	—	—
C	—	±	+	+	+	—	—	—	—	±
D	—	+	+	+	+	—	—	—	—	—
E	—	±	+	+	+	—	—	—	—	—
F	—	±	+	+	+	—	—	—	—	—

Name.[a]	March 6.									
	Globulin precipitation reaction.					Wassermann reaction.				
	1:1	1:2	1:3	1:4	1:5	Alc. ant. 1/5	Alc. ant. 1/10	Ser. con. 1/10	Chol. ant. 1/5	Chol. ant. 1/10
A	—	—	+	+	+	—	+	—	—	+
B	—	±	+	+	+	—	±	—	—	++
C	—	—	+	+	+	—	+	—	—	+
D	±	+	+	+	+	—	++	—	—	++
E	—	±	+	+	+	—	±	—	—	+
F	—	±	+	+	+	—	—	—	—	±

[a] The designation of patient is the same as that used in earlier papers on yaws; see Philip. Journ. Sci. **22** (1923) 219–285.

TABLE 5.—*Showing the progress of globulin precipitation and the Wassermann reaction in yaws during the course and treatment of the disease*—Continued.

Name.[a]	March 21.									
	Globulin precipitation reaction.					Wassermann reaction.				
	1:1	1:2	1:3	1:4	1:5	Alc. ant.		Ser. con.	Chol. ant.	
						1/5	1/10	1/10	1/5	1/10
A	—	—	+	+	+	—	+	—	—	++
B	—	—	+	+	+	—	±	—	—	++
C	—	—	+	+	+	—	+	—	—	+
D	±	+	+	+	+	—	++	—	—	++
E	—	—	+	+	+	—	+	—	—	++
F	—	—	+	+	+	—	±	—	—	+

Name.[a]	March 30.									
	Globulin precipitation reaction.					Wassermann reaction.				
	1:1	1:2	1:3	1:4	1:5	Alc. ant.		Ser. con.	Chol. ant.	
						1/5	1/10	1/10	1/5	1/10
A	—	+	+	+	+	—	+++	—	+	++++
B	—	±	+	+	+	—	++	—	—	+++
C	0	0	0	0	0	0	0	0	0	0
D	0	0	0	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0	0	0	0
F	0	0	0	0	0	0	0	0	0	0

Name.[a]	April 6.									
	Globulin precipitation reaction.					Wassermann reaction.				
	1:1	1:2	1:3	1:4	1:5	Alc. ant.		Ser. con.	Chol. ant.	
						1/5	1/10	1/10	1/5	1/10
A	0	0	0	0	0	0	0	0	0	0
B	0	0	0	0	0	0	0	0	0	0
C	—	+	+	+	+	—	++	—	—	++
D	—	+	+	+	+	—	++	—	—	++
E	—	—	+	+	+	—	++	—	—	++
F	0	0	0	0	0	0	0	0	0	0

[a] The designation of patient is the same as that used in earlier papers on yaws; see Philip. Journ. Sci. **22** (1923) 219–285.

TABLE 5.—*Showing the progress of globulin precipitation and the Wassermann reaction in yaws during the course and treatment of the disease*—Continued.

Name.[a]	April 15.									
	Globulin precipitation reaction.					Wassermann reaction.				
	1 : 1	1 : 2	1 : 3	1 : 4	1 : 5	Alc. ant.		Ser. con.	Chol. ant.	
						1/5	1/10	1/10	1/5	1/10
A	—	±	+	+	+	—	—	—	—	—
B	—	+	+	+	+	—	—	—	—	+
C	—	+	+	+	+	—	++	—	—	++
D	+	+	+	+	+	—	+	—	—	++
E	—	+	+	+	+	—	+	—	—	++
F	0	0	0	0	0	0	0	0	0	0

Name.[a]	April 29.									
	Globulin precipitation reaction.					Wassermann reaction.				
	1 : 1	1 : 2	1 : 3	1 : 4	1 : 5	Alc. ant.		Ser. con.	Chol. ant.	
						1/5	1/10	1/10	1/5	1/10
A	—	—	+	+	+	—	—	—	—	—
B	—	—	+	+	+	—	—	—	—	—
C	±	+	+	+	+	—	—	—	—	—
D	—	+	+	+	+	—	—	—	—	±
E	—	—	+	+	+	—	—	—	—	—
F	—	+	+	+	+	—	+	—	—	++

Name.[a]	June 1.									
	Globulin precipitation reaction.					Wassermann reaction.				
	1 : 1	1 : 2	1 : 3	1 : 4	1 : 5	Alc. ant.		Ser. con.	Chol. ant.	
						1/5	1/10	1/10	1/5	1/10
A	—	—	+	+	+	—	—	—	—	—
B	[b]—	—	+	+	+	—	—	—	—	±
C	[b]—	—	—	—	+	—	—	—	—	—
D	[b]—	—	+	+	+	—	—	—	—	—
E	—	—	±	+	+	—	—	—	—	—
F	[b]—	—	+	+	+	—	—	—	—	±

[a] The designation of patient is the same as that used in earlier papers on yaws; see Philip. Journ. Sci. 22 (1923) 219–285.

[b] Hæmolysis.

TABLE 5.—*Showing the progress of globulin precipitation and the Wassermann reaction in yaws during the course and treatment of the disease*—Continued.

Name.[a]	July 2.										
	Globulin precipitation reaction.					Wassermann reaction.					Lymphadenitis.
	1:1	1:2	1:3	1:4	1:5	Alc. ant.		Ser. con.	Chol. ant.		
						1/5	1/10	1/10	1/5	1/10	
A	—	—	±	+	+	—	—	—	—	—	–
B	—	—	—	+	+	—	—	—	—	±	—
C	—	—	+	+	+	—	—	—	—	—	++
D	—	+	+	+	+	—	—	—	—	—	++
E	—	—	—	±	+	—	—	—	—	—	—
F	—	+	+	+	+	—	—	—	—	—	++++

[a] The designation of patient is the same as that used in earlier papers on yaws; see Philip. Journ. Sci. **22** (1923) 219–285.

The results show that three days after the inoculation with *Treponema pertenue* took place (that is, on January 21) all gave a normal serologic picture with regard to the Wassermann reaction and the globulin precipitation test. A faint precipitate was found in the dilution of the serum with distilled water in the proportion of 1: 3 in four of the six patients. This faint precipitate frequently forms on the border line of the positive dilution and redissolves on standing at room temperature for twenty-four hours. Three weeks after inoculation (February 14), the Wassermann reaction still remained negative, but the globulin precipitation reaction became pronounced in all cases in the dilution 1: 3, in two cases in the dilution 1: 2, and the remaining patients gave a faint precipitation in the 1: 2 dilution. At that time the Wassermann reaction was still negative but it became distinctly positive in five patients (A, B, C, D, and E) on March 6, three weeks after the globulin test was found distinctly positive. On this date the sixth case (F) showed a ± Wassermann test. From this time on the Wassermann reaction became stronger, and the globulin precipitation maintained its height, with slight variations, until April 15. The treatment of patients A and B was begun on April 1 and of patients C, D, and E on April 7. Patient F did not receive treatment until May 5. Following treatment the Wassermann reaction rapidly became negative. Patient F, who had not received treatment until May 5, continued to give positive Wassermann reactions until

June 1, on which date the test showed slight inhibition of hæmolysis in the tube containing cholesterinized antigen and 1:10 complement. The decline of the positive globulin precipitation reaction following the treatment was much slower, and distinctly positive results were obtained at the time when the treated cases gave negative Wassermann tests. Indeed, three months (and more in some cases) after the Wassermann test had been found negative the globulin precipitation test showed positive results in the majority of the cases in the 1:3 dilution.

The results of these comparative successive tests before and after acquisition of yaws and during treatment are very interesting, in as much as they show that the globulin precipitation reaction in yaws will become distinctly positive in the pre-Wassermann stage; that it maintains its strength throughout the acute course of the disease; and that, though the Wassermann test becomes negative rather abruptly following specific treatment, the globulin precipitation reaction declines gradually and is distinctly positive in the post-Wassermann stage of the disease. The globulin precipitation reaction therefore in yaws as a prodromal and anamnestic reaction is more sensitive than the Wassermann reaction. The rapidity with which the cutaneous manifestations of acute yaws disappear following one or two injections of neosalvarsan created the impression that one or two injections of the specific drug are sufficient to cure a case of yaws. The results of our work show, however, that in a certain proportion of cases one or two injections are not sufficient to bring about a complete clinical and serological cure, because in a good many cases, after the cutaneous manifestations had disappeared, the Wassermann reaction still persisted. There is a striking parallelism between the persistence of the residual clinical symptoms (lymphadenitis) and the persistence after treatment of positive globulin precipitation reaction. We have here brought out evidence that, for some time at least, after the clinical and serologic (Wassermann) cure has been accomplished there is yet evidence of pathologic changes in the serum of the healed yaws patients which can be made evident by the globulin precipitation test.

Another point of interest has been brought out by repeated examination of the blood of the patients referred to in the second part of this paper. On July 2, when the patients were examined, they were found clinically normal. The cutaneous manifestation had disappeared completely and the size of the

glands was reduced to such an extent that, had we not known the previous condition of the glands, either they would have been overlooked or their slight intumescence would have been considered as due to another cause. Being familiar, however, with the clinical condition of the patients from the beginning of the infection, and considering particularly the rapid decrease in size of the glands after the specific treatment for yaws, we paid especial attention to the condition of the glands and found that in three of the six cases there still persisted a more or less pronounced adenitis. (See Table 5.) If these patients had reported for serological examination without their previous history being known the globulin precipitation reaction would have been found strongly positive in at least two, pronounced in one, and doubtful in one of the six apparently normal persons. This observation of the persistence of globulin precipitation reaction (a nonspecific reaction which may be due to any of several diseases) is of importance, in as much as difficulties may be encountered by authors using the globulin precipitation test to set a definite standard for this reaction in healthy persons. In localities where syphilis, yaws, or leprosy is prevalent there is little doubt that persons whose serum gives a positive precipitation have suffered previously with one or other of the diseases that are accompanied by positive globulin precipitation reaction. Of these diseases yaws is most likely to be misleading, due to the fact that very frequently no trace whatever is left of a yaw granuloma once it is healed, and yet, as evident from this investigation, the globulin precipitation reaction persists.

SUMMARY AND CONCLUSIONS

1. The globulin precipitation test with distilled water was found positive in at least a 1:3 dilution in every one of the twenty-four active yaws patients examined. In certain cases the reaction was very strong, in as much as precipitation occurred in as low a dilution as 1:1.

2. Healed cases of yaws showed less-pronounced precipitation than did the active cases, but a good many still gave positive reactions.

3. Both qualitatively and quantitatively the results of this test and of the Wassermann reaction did not always agree.

4. Experimental evidence is produced that the globulin of the patient's serum which precipitates upon dilution with distilled water is not the carrier of the Wassermann antibody.

5. The globulin precipitation reaction with distilled water becomes positive shortly after the infection with *Treponema pertenue* sets in and is pronounced in the "pre-Wassermann" stage. It maintains its strength throughout the course of the disease and is still positive long after the Wassermann reaction becomes negative through specific treatment. As a prodromal and anamnestic reaction in yaws the globulin precipitation reaction is more sensitive than is the Wassermann reaction.

6. The practical value of the globulin precipitation reaction as a confirmatory test of clinical diagnosis of yaws in the pre-Wassermann stage and as a useful reaction for the guidance of the extent of specific treatment necessary in a given case of yaws is strongly indicated.

7. Due to the simplicity of technic, the reaction under discussion may prove to be of value in antiyaws campaigns in locations where conditions make the carrying out of the Wassermann reaction impracticable.

A CLINICAL MODIFICATION OF YAWS OBSERVED IN PATIENTS LIVING IN MOUNTAINOUS DISTRICTS [1]

By LEONCIO LOPEZ-RIZAL

Chief, Division of Communicable Diseases, Philippine Health Service

and

ANDREW WATSON SELLARDS

Of the Harvard Medical School, Department of Tropical Medicine, and the Bureau of Science

TWO PLATES

The widespread dissemination of syphilis throughout the world is rendered possible by the fact that *Treponema pallidum* is independent of climatic conditions. The reverse is true of *Treponema pertenue.* Of the infectious diseases which have no intermediate insect host, yaws is one of the few that are limited by nature to the Tropics. When accidentally introduced into temperate zones yaws does not gain a foothold. Within the Tropics, typical cases are found for the most part only in the low warm regions. Indeed, it has come to be a textbook statement [2] that the disease practically does not occur above an altitude of 800 feet (about 270 meters). An exception was noted by Ricono,[3] who described eight cases in Africa occurring at an average elevation of 5,500 feet (about 1,800 meters). The clinical findings in these patients were not especially remarkable. The lesions were widely distributed over the body. Iritis was noted in two cases and condylomata like those in syphilis were present in others. Ricono states that, without any previous history, the most obvious diagnosis in three of the eight cases would have been syphilis. However, he expresses practically no doubt about the correctness of the diagnosis of yaws in the entire group.

[1] From the Philippine Health Service and the Bureau of Science, Manila.

[2] Castellani, A., and A. J. Chalmers, Manual of Tropical Medicine, 3d ed. London. Baillière, Tindall & Cox (1919) 1537.

[3] South African Med. Rec. 14 (1916) 83.

Oho [4] describes an isolated endemic focus of yaws in the mountains of Formosa at an altitude of about 5,000 feet. He noted typical skin lesions, and the diagnosis of yaws was confirmed by histological section.

Mattlet [5] reports that yaws is abundantly present in the mountainous regions of Kitega, in Africa, the elevation varying from about 5,200 to 6,600 feet (1,600 to 2,000 meters). He emphasizes the tertiary lesions of the adults resulting in deformities of the long bones, ankylosis of the joints, erosion of the mucous membranes, and destruction of the bones of the face.

Gilks,[6] in the treatment of more than thirty thousand cases of yaws in the Kenya Colony in East Africa, noted that many cases occurred at altitudes of 5,000 feet, but he observed that the disease was particularly prevalent in some of the warmer, low-lying localities. No description is given of the clinical symptoms of the patients observed at high altitudes.

In the heavily populated Dutch East Indies there are many hundred thousands of yaws cases. Winkel [7] mentions some interesting points in the distribution of these patients. In Java the disease is prevalent in the low countries and its incidence decreases gradually in proportion to the altitude; it is absent in the plateaus, even in districts where the natives are very uncleanly in their habits. On the contrary, in Sumatra many cases are found at a height of 3,000 feet, an elevation much greater than the plateaus of Java. Winkel's report is not concerned in any way with the clinical symptoms of the patients.

In Ceylon, Bahr [8] found that yaws, though prevalent in the lowlands, was extremely rare above an altitude of 800 feet. Although yaws has now been reported from fairly high altitudes in widely separated parts of the tropical world, it seems clear that the disease flourishes characteristically in the low-lying warm districts, preferably within at least a few hundred feet of sea level.

We have recently observed some cases of yaws showing interesting clinical modifications. In the Philippines, in the mountains of northern Luzon, there is an extremely interesting group

[4] Trans. Fourth Congress Far Eastern Assoc. Trop. Med. 2 (1921) 138.

[5] Ann. de la Soc. Belge de la Med. Trop. 2 (1922) 156.

[6] Trans. Roy. Soc. Trop. Med. & Hyg. 17 (1923) 277.

[7] Meded. v. d. Burgerlijken Geneesk. Dienst in Nederl. Ind., Part 3 (1923) 213.

[8] Ann. Trop. Med. & Parasitol. 8 (1914–1915) 675.

of people. They are probably of ancient Malay origin, but they now live in the mountains quite apart from the inhabitants of the lowlands and have developed their own dialect, mode of dress, and social customs. Yaws is prevalent in Ifugao Subprovince, and the cases there are typical of the disease as it occurs in Mountain Province. At Kiangan, in Ifugao, Dr. Rafael Jagunap of the Philippine Health Service requested the yaws patients in the vicinity to report for treatment. Twenty-eight presented themselves; these, together with five others already under treatment in the hospital, form the basis of this report.

DISTRIBUTION OF LESIONS

The patients showed involvement of the muco-cutaneous junctures around the mouth, the nose, the anus, and the genitalia. It was practically impossible from the history to determine the location of the primary lesion.

Of the thirty-three patients seen in Kiangan, seventeen were children between the ages of 2 and 13 years, and the remainder were adults. Lesions of the anus or genitalia were noted in twenty-nine cases, and of these ten showed no involvement of the mouth or the nose. Not infrequently the anus alone was involved, but in female patients it seemed only a question of time for the infection to spread to the vulva. There were twenty-two cases, in all, showing lesions of the mouth or nose, and in four of these neither the anus nor the genitalia were as yet involved.

Occasionally the infection extends to the immediately adjacent areas by direct continuity (Plate 1, fig. 1.), or by direct contact, but usually the disease runs its entire course without any generalized development of granulomata over the body.

Only five of the thiry-three cases showed any evidence of metastatic involvement of the skin in areas more or less remote from the muco-cutaneous lesions. One of these five had a few papules over the bridge of the nose (Plate 1, fig. 2) ; a second had granulomata in one axilla; a third showed macular lesions in the palms of both hands (Plate 1, figs. 3 and 4) ; a fourth had papules over the eyebrows and on the scalp; a fifth case showed two granulomata on the right fore arm, one on the left shoulder, and several in the palms. The contrast between the typical cases of the mountains and those of the lowlands is shown in Plates 1 and 2.

During the years 1923 and 1924, Dr. Francisco Gomez and Dr. Rafael Jagunap treated two hundred twenty-two cases of

yaws in Mountain Province; one hundred twelve of these patients were children and one hundred ten were adults. Of the entire group, only nineteen showed any metastatic lesions.

CHARACTER OF LESIONS

The general appearance of the lesions around the muco-cutaneous junctures is shown in the accompanying illustrations. Clinically they look suspiciously like syphilitic condylomata, and they have occasionally been diagnosed as such. They do not conform to granuloma inguinale. Six typical cases were tested for the Wassermann reaction and complete fixation occurred in each instance. In another case, practically cured by treatment, the reaction was moderately strong (++). There is no doubt in our own minds that these lesions are due to yaws. These patients do not show any manifestations peculiar to syphilis. Moreover, in three cases of this group typical granulomata were found, either near these condylomalike lesions or on remote parts of the body.

The result of animal inoculation is consistent with the diagnosis of yaws. A patient was selected who showed condylomalike lesions around the mouth and anus, but no typical granulomata. Scrapings from these lesions were suspended in saline and injected intradermally in the eyebrows of three young monkeys (*Pithecus philippinensis*). In one of these animals lesions developed after five weeks which, clinically, were suggestive of yaws. The usual treponemata were seen on examination with the dark field.

The extensive involvement of the genitalia might readily suggest sexual transmission and, indeed, some patients gave a more or less definite history of having contracted the disease in this manner; but, at most, this can only be an accessory mode of transmission for in the mountains, as in the lowlands, the infection is prevalent among children. Tertiary manifestations appear to be rare. Dr. R. Jagunap during the course of two years of duty in Ifugao could recall only one patient in whom the nasal lesions progressed to the destructive stage of rhinopharyngitis mutilans—that is, gangosa. Dr. F. Gomez, during two years of service, found six cases of gangosa in the remote districts of Ifugao.

According to the vague accounts of the patients, untreated cases usually regress spontaneously within about one year. The native chiefs state that yaws has existed in the mountains from time immemorial. Their local name for it, "gang-a-gang," is totally unlike any of the names used in any other part of the Philippines. The disease is certainly endemic in Mountain Province, for there is no contact with the distant yaws centers in the lowlands, the nearest one of importance being 150 kilometers away, in Ilocos Sur. There is an absolute minimum of communication between the mountain tribes and the Christian Filipinos of the lowlands. Indeed, within Mountain Province among people of their own tribe, natives steadfastly refuse to go more than a short day's journey (30 kilometers) from their own homes.

LIMITATION OF THE SKIN MANIFESTATIONS

The infection is not restricted to the muco-cutaneous lesions, because the lymphatic glands, the inguinals, the epitrochlears, the axillary, and the posterior cervicals and auriculars are definitely and sometimes enormously enlarged in a typically indolent fashion. The limitation of the skin lesions to the mucocutaneous orifices of the body is inexplicable at present. The first factor for consideration is the question of clothing and climate. The men and boys wear nothing but a breechcloth; the women wrap a broad piece of cloth loosely around the loins, giving little protection from the cold. The principal occupation of the natives is working in the rice terraces.

We have observed cases of yaws at elevations varying from 600 to 2,100 meters but the average altitude at which the majority of the patients live may be roughly estimated at 800 to 1,200 meters. The effect of altitude upon the climate of this region is particularly noticeable in the minimum temperatures. No climatological data are available for Kiangan, but Bokod, a typical station in Mountain Province, at an elevation of 900 meters, may be suitably compared with Manila, situated on the shores of Manila Bay. The records of the monthly temperatures for these two stations, presented in Table 1, were supplied through the kindness of Father Miguel Selga, acting director of the Weather Bureau.

TABLE 1.—*Comparison of the extreme monthly temperatures of typical stations in Mountain Province (Bokod, 2,800 feet elevation) and in the lowlands (Manila), calculated for the three-year period from 1922 to 1924.*

AVERAGE MAXIMUM TEMPERATURE °C.

Station.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Bokod	28.0	29.4	30.7	31.3	30.4	28.8	27.8	26.3	27.9	27.4	28.1	28.3
Manila	30.4	31.7	32.3	34.8	33.6	31.9	30.8	30.4	31.2	31.3	30.5	30.1

AVERAGE MINIMUM TEMPERATURE °C.

Station.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Bokod	13.9	14.4	15.8	16.8	17.2	18.2	18.6	18.5	18.1	16.7	16.2	15.5
Manila	20.5	20.7	21.2	22.6	23.9	24.2	23.8	24.0	23.8	23.0	22.4	21.4

This difference in temperature, though not extreme, is of some significance. Even in the continuous warmth of the lowlands the granulomata of yaws show a definite predilection for the protection afforded by the warm moist areas of the body. If it should be proven eventually that low temperature is an important factor in limiting the spread of the granulomata over the body, then it is all the more interesting that a drop of a comparatively few degrees should be sufficient to effect this limitation. Reports from various parts of the world show considerable variation in the ease with which yaws established itself in mountainous districts of similar elevation. Aside from the question of temperature, the amount of rainfall and the degree of humidity may exert some influence, since yaws is characteristically a disease of warm moist countries rather than of arid regions. As already mentioned, Winkel has reported that yaws is prevalent in the high plateaus of Sumatra, but absent in corresponding altitudes of Java. The high mountains of Sumatra are wet throughout the year, and the contrast with Java, particularly with East Java, is very noticeable in the vegetation.[9] However, it is obvious that the information concerning the climate and the distribution of yaws in the Dutch East Indies is not sufficiently complete to permit any definite conclusions being drawn therefrom.

On hypothetical grounds we may consider that a special strain of yaws of low dermatotropic affinity has developed in these

[9] Braak, C., The Climate of the Netherlands Indies 1 [1]. English Summary, page 17.

tribes in Ifugao, cut off for centuries from communication with the outside world. At present there is no evidence to support such a supposition. If such a strain exists, it has not spread to the lowlands in the Philippines. We have not yet been able to perform the obvious and apparently simple experiment of inducing some of these patients in the early stage of the disease to leave the mountains and live for a few weeks in the lowlands. This would afford the advantage of a favorable climate for permitting the granulomata to appear on various parts of the body.

SUMMARY

Yaws is widespread in the mountains of northern Luzon, at elevations varying from approximately 600 to 2,100 meters. The disease is endemic in the mountains and propagates itself independently of any communication with inhabitants from the yaws centers of the lowlands.

Clinically, the yaws cases that occur in the mountains show a striking peculiarity in that the cutaneous lesions in the majority of the patients (90 per cent) are limited to the muco-cutaneous junctures of the mouth, nose, anus, and genitalia. The explanation for this modification in the distribution of the skin lesions is not evident. Systemic distribution of the treponemata in these patients is indicated by the generalized enlargement of the lymphatic glands.

ILLUSTRATIONS

PLATE 1. CASES OF YAWS FROM MOUNTAIN PROVINCE, LUZON

FIGS. 1 and 2. Lesions of the mouth, nose, and chin.
3 and 4. Case showing palmar frambœside.
5 and 6. Lesions of the anus.

PLATE 2

FIGS. 1 and 2. Cases of yaws from Mountain Province.
3 and 4. A case of yaws from Parañaque, showing generalized distribution of the granulomata characteristic of patients in the lowlands.

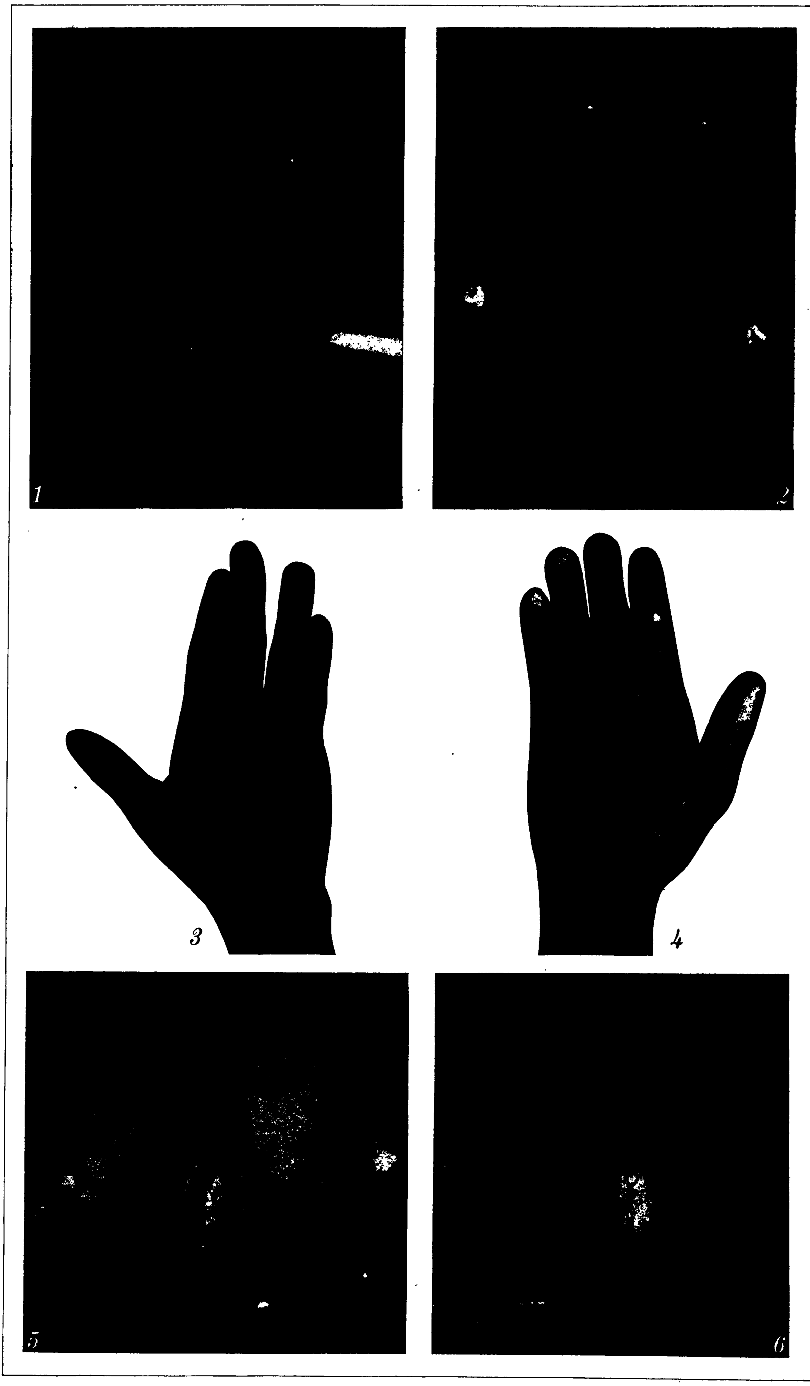
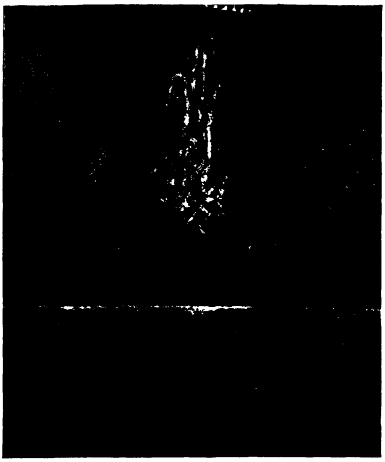


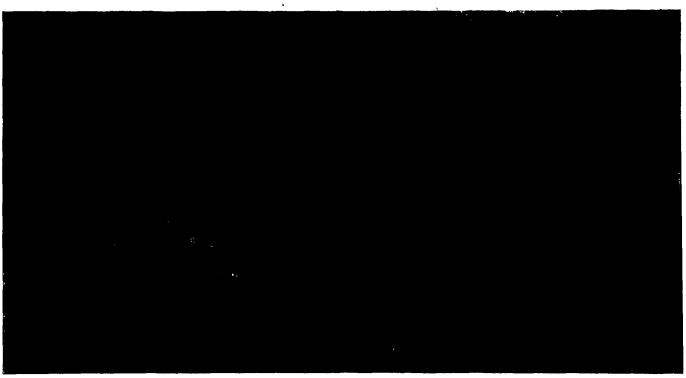
PLATE I.



1

2

3



4

PLATE 2.

ERRATUM

Vol. 29, page 392, for lines 1 to 5 substitute—

Elaeocarpus pedunculatus Wall.

Elaeocarpus pedunculatus Wall.; MERR., Enum. Born. Pl. (1921) 371.

No. 1739, from Balambangan Island, in forests. Malay Peninsula, Penang, Singapore, and Borneo.

INDEX

[New generic and specific names and new combinations are printed in **clarendon**; synonyms and names of species incidentally mentioned in the text are printed in *italic*.]

R

S

T

218657——9

O

CONTENTS

The Philippine Journal of Science is issued twelve times a year. The sections were discontinued with the completion of Volume XIII (1918).

Yearly subscription, beginning with Volume XIV, 5 dollars United States currency. Single numbers, 50 cents each.

Publications sent in exchange for the Philippine Journal of Science should be addressed: Library, Bureau of Science, Manila, P. I.

Subscriptions may be sent to the BUSINESS MANAGER, Philippine Journal of Science, Bureau of Science, Manila, P. I., or to any of the agents listed on the third page of this cover.

Entered at the post office at Manila, P. I., as second-class matter.

VOL. 30, NO. 4 AUGUST, 1926

THE PHILIPPINE JOURNAL OF SCIENCE

MANILA
BUREAU OF PRINTING
1926

218657

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science of the Government of the Philippine Islands

---

Manuscript intended for publication should be sent to the editor. One hundred separates of each paper published in the Journal are furnished to the author without charge. Additional copies may be had at the author's expense if ordered when the manuscript is submitted for publication.

Publications sent in exchange for the Philippine Journal of Science should be addressed: Library, Bureau of Science, Manila, P. I.

The Journal is issued twelve times a year. The subscription price is 5 dollars, United States currency, per year. Single numbers, 50 cents each.

Subscriptions may be sent to the BUSINESS MANAGER, Philippine Journal of Science, Bureau of Science, Manila, P. I., or to any of the agents listed on the third page of this cover.